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# The Australian Tertiary Mollusca of the Family Turridae

By A. W. B. POWELL, Assistant-Director.

This paper is based upon an extensive collection of Australian Tertiary Turridae put together by Dr. H. J. Finlay of Wellington. The collection is augmented by material from Dr. C. R. Laws, of Auckland, as well as series collected by Dr. R. S. Allan, of Christchurch, Mr. W. J. Parr, of Melbourne, and the writer. All this material, including the holotypes, is now in the Auckland Museum.

In 1943 (Bulletin of the Auckland Institute and Museum, No. 2) the writer published "The New Zealand Recent and Fossil Mollusca of the Family Turridae." The present paper should be studied in conjunction with the New Zealand monograph, for a basis of comparison exists, particularly in respect to the Middle and Lower Miocene, which are well represented in both countries.

The recognition in the Australian Miocene of such characteristic New Zealand genera as *Austrotoma, Zemacies, Insolentia, Comitas, Carinacomitas, Hauturua* and *Rugobela* is noteworthy. A table is given which shows at a glance the composition and certain interrelationships of the Turrid faunas of both countries from Tertiary to Recent times.

Australian Tertiary Molluscan faunas, so far as is known, are incompletely represented. The Eocene has been recognised only recently by Singleton (1943, pp. 267-278), but no gasteropods were recorded. The Oligocene has not provided mollusca, unless by further stratigraphical study it is found desirable to refer here, as uppermost Oligocene, the lower sections of deep borings at present considered basal Janjukian (see Singleton, 1941, pp. 12, 13). I have no material from either the Cheltenhamian (Upper Miocene) or the Werrikooian (Upper Pliocene), but Dennant and Kitson (1903, p. 142) recorded eight Turrids from the latter. Six of these occur in the Australian Recent fauna and two are doubtful records of Miocene species.

This paper covers description of 91 new species, 7 new genera and 3 new subgenera, which brings the Australian Tertiary Turrid fauna to a total of 164 species, more than double the number previously recognised. At least a further twenty new species, belonging to genera already recorded for the Australian Tertiary, are represented in the Finlay collection by solitary examples not good enough for description.

## TURRID GENERA OF AUSTRALIA AND NEW ZEALAND*

| NEW ZEALAND | | | | | | | | | | | | | TURRIDAE | AUSTRALIA | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| E | | | O | | | M | | | P | | | R | (TURRINAE) | E | O | M | | | | P | | | R | |
| | | | | | | | | | | | | | TURRIS | | | | | ● | · | · | · | · | ● | † |
| | | | | | | | | | | | | | LOPHIOTOMA | | | | | ● | · | · | · | · | ● | † |
| | | | | | | | | | | | | | XENUROTURRIS | | | | | ● | · | · | · | · | ● | † |
| | | | | | | | | | | | | | (VERUTURRIS) | | | ● | · | ● | · | · | ● | | | |
| | | | | | | | | | | | | | CLAMTURRIS | | | | | | | | | | ● | |
| | | | | | | | | | | | | | OPTOTURRIS | | | ● | · | ● | | | | | | |
| · | ● | ● | · | · | ● | ● | · | ● | ● | | | | GEMMULA | | | | | ● | · | · | · | · | ● | † |
| | ● | ● | · | · | ● | | | | | | | | EOTURRIS | | | | | | | | | | | |
| | | | | | | ● | ● | | | | | | ECHINOTURRIS | | | | | | | | | | | |
| | | | | | | ● | ● | | | | | | BATHYTOMA | | | | | | | | | | | † |
| | | | | | | ● | ● | ● | ● | ● | ● | ● | MICANTAPEX | | | ● | ● | ● | · | ● | · | · | ● | † |
| | | | | | | | | | | | | | LUCERAPEX | | | | | | | | | | ● | |
| | | | | | | | | | | | | | EPIDIRONA | | | ? | · | ● | · | · | ● | ● | ● | |
| | | | | | | | | | | | | | EPIDIRELLA | | | | | | | ● | · | · | ● | |
| | | | | | | | | | | | ● | ● | FENESTROSYRINX | | | | | | | | | | ● | |
| | | | | | | | | | | | | | (TURRICULINAE) | | | | | | | | | | | |
| | | | | | | ● | ● | ● | ● | ● | · | ● | COMITAS | | | ● | · | ● | | | | | | |
| | | | | | | ● | | | | | | | (CARINACOMITAS) | | | ● | · | ● | | | | | | |
| | | | | | | | | | | ● | ● | ● | PARACOMITAS | | | | | | | | | | | |
| | | | | | | | | | | | | ● | ANTICOMITAS | | | | | | | | | | | |
| | ● | · | · | · | ● | ● | ● | | | | | | INSOLENTIA | | | ● | | | | | | | | |
| | | | | | | | | | | | | | APIOTOMA | | | ● | · | ● | | | | | | † |
| | ● | · | · | · | ● | ● | ● | ● | ● | | | | ZEMACIES | | | ● | | | | | | | | |
| | | | | | | | | | | | | | (COCHLESPIRINAE) | | | | | | | | | | | |
| | | | | | | | | | | | | | CORONASYRINX | | | ● | · | ● | | | | | | † |
| | | ● | | | | | | | | | | | TAHUSYRINX | | | | | | | | | | | |
| | | | | | ● | | | | | | | | LIRASYRINX | | | | | | | | | | | |
| | | | | | ● | · | ● | | | | | | PARASYRINX | | | | | | | | | | | |
| | | | | | ● | ● | ● | | | | | | COSMASYRINX | | | | | | | | | | | |
| | | | | | | | | | | | | | (CONORBIINAE) | | | | | | | | | | | |
| | | | | | | | | | | | | | CONORBIS | | | ? | | | | | | | | † |
| | ? | | | | | | | | | | | | CRYPTOCONUS | | | | | | | | | | | † |
| ? · | · | · | · | · | ● | ● | ● | ● | ● | | | | AUSTROTOMA | | | ● | | | | | | | | |
| | | | | | | | | | | | | | BELOPHOS | | | ● | | | | | | | | |

*E — R = Eocene, Oligocene, Miocene, Pliocene and Recent.

*New Zealand stages* — Eocene (——, Bortonian, Tahuian); Oligocene (Kaiatan, Whaingaroan, Waitakian); Miocene (Hutchinsonian, Awamoan, Urenuian — Tongaporutuan); Pliocene (Opoitian — Waitotaran, Nukumaruan, Castlecliffian).

*Austrailian stages* — Miocene (Janjukian, Batesfordian, Balcombian, Cheltenhamian); Pliocene (Kalimnan, Adelaidean, Werrikooian).

†Indicates genera with a wider distribution than Australia and New Zealand.

| | NEW ZEALAND | | | | | | | | | | | | | | AUSTRALIA | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | E | | | O | | | M | | | P | | | R | | E | O | M | | | | P | | | R | |
| | | | | | | | | | | | | | | BELATOMINA | | | ● | · | ● | | | | | | |
| | | | | | | | | | | | | | | LIRATOMINA | | | ● | · | ● | · | · | ● | | | |
| | | | | | | | | | | | | | ● | VEXITOMINA | | | | | | | | | | ● | |
| | | ● | ● | | | | | | | | | | | NOTOGENOTA | | | | | | | | | | | |
| ● | · | ● | ● | · | · | ● | · | ● | | | | | | MARSHALLARIA | | | | | | | | | | | |
| | | ● | ● | ● | · | · | · | ● | ● | ● | | | | MARSHALLENA | | | | | | | | | | | |
| | | | | | | | | | | | | | | (CLAVINAE) | | | | | | | | | | | |
| | | | ● | · | · | · | ● | ● | | | | | | INQUISITOR | | | | | | | | ● | · | ● | † |
| | | ? | · | · | · | · | ● | ● | | | | | | PSEUDOINQUISITOR | | | | | ● | · | ● | · | · | ● | |
| | | | | | | | | | | | ● | ● | ● | ANTIMELATOMA | | | | | | | | | | | |
| | | | | | | | | | | | | | | AUSTRODRILLIA | | | | | | | | | | ● | |
| | | | | | | | | | | | | | ● | (REGIDRILLIA) | | | | | | | | | | | |
| | | | | | | | | | | ● | | | | CLAVATOMA | | | | | | | | | | | |
| | | | ● | | | | | | | | | | | TAHUDRILLIA | | | | | | | | | | | |
| | | | | | | ● | ● | ● | · | ● | | | | MAUIDRILLIA | | | ● | · | ● | · | ● | · | · | ● | |
| | | | | | | | ● | ● | ● | ● | ● | ● | | AOTEADRILLIA | | | | | | | | | | | |
| | | | | | | | | | | | | | | VIXINQUISITOR | | | | ● | ● | | | | | | |
| | | | | | | | | | | | | | | INTEGRADRILLIA | | | | | ● | | | | | | |
| | | | | | | | ● | ● | · | ● | ● | ● | ● | SPLENDRILLIA | | | | | ● | · | ● | ● | ● | ● | |
| | | | | | | | ● | | | | | | | SYNTOMODRILLIA | | | ● | · | ● | · | · | ● | | | † |
| | | | | | | | ● | ● | · | · | · | · | ● | (HAUTURUA) | | | | | | | ● | | | | |
| | | | | | | | ● | ● | · | ● | ● | ● | ● | PHENATOMA | | | | | | | | | | | † |
| | | | | | | | | | | | ● | | | MITRELLATOMA | | | | | | | | | | | |
| ● | · | · | · | · | · | ● | ● | ● | | | | | | TOMOPLEURA | | | | | | | ● | ● | · | ● | † |
| | | | | | | ● | ● | ● | · | ● | ● | ● | ● | MAORITOMELLA | | | ● | · | ● | · | · | ● | · | ● | |
| | | | | | | | ● | | | | | | | MICRODRILLIA | | | | | ● | · | · | · | · | ● | † |
| | | | | | | | | | ● | | | | | TURRIDRUPA | | | | | | | | | | ● | † |
| | | | | | | | ● | ● | | | | | | AUSTROCLAVUS | | | | | ● | · | · | · | · | ● | |
| | | | | | | | | | | | | | | IREDALEA | | | | | | | | | | ● | † |
| | | | | | | | | | | | | | | (BORSONIINAE) | | | | | | | | | | | |
| | | ● | · | · | · | ● | ● | | | | | | | BORSONIA | | | ● | | | | | | | | † |
| | | | ● | | | | | | | | | | | CORDIERIA | | | | | | | | | | | † |
| | | | | | | | | | ● | | | | | BORSONELLA | | | | | | | | | | | † |
| | | | | | | | | | | | | | | CRYPTOBORSONIA | | | ● | · | ● | | | | | | |
| | | | ● | | | | | | | | | | | EOSCOBINELLA | | | | | | | | | | | |
| | | | | | | ● | · | ● | · | ● | · | · | ● | MITRITHARA | | | | | ● | · | · | · | · | ● | |
| | | | | | | | ● | · | · | · | · | · | ● | ITIA | | | | | | | | | | | |
| | | | | | | | | ● | | | | | | VEXITHARA | | | | | | | | | | | |
| | | | | | | | | | | | | | ● | MAORIMORPHA | | | | | | | | | | | |
| | | | | | | | | | ● | ● | ● | | | AWATERIA | | | | | | | | | | ? | |
| | | | | | | ● | · | ● | ● | ● | · | · | ● | SCRINIUM | | | ● | · | ● | | · | · | · | ● | |

| NEW ZEALAND | | | | | | | | | | | | | | AUSTRALIA | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| E | | | O | | | M | | | P | | | R | (MANGELIINAE) | E | O | M | | | | P | | | R | |
| | | | | | | | | | | | | | GURALEUS | | | ● | · | ● | · | ● | ● | ● | ● | |
| | | | | | | | | | | | | | (PARAGURALEUS) | | | ● | · | ● | · | · | ● | · | ● | |
| | | | | | | | | | | | | | MARITA | | | | | | | | | | ● | |
| | | | | | | | ● | · | ● | ● | ● | ● | NEOGURALEUS | | | | | | | | | | | |
| | | | | | ● | ● | ● | · | ● | | | | (FUSIGURALEUS) | | | | | | | | | | | |
| | | | | | | ● | | | | | | | VEXIGURALEUS | | | | | | | | | | | |
| | | | | | | | | ● | · | ● | · | ● | ANTIGURALEUS | | | | | | | | | | | |
| | | | | | | | | | | | | | MAPPINGIA | | | | | | | | ● | | | |
| | | | | | | | | | | ● | · | ● | LIRACRAEA | | | | | | | | | | | |
| | | | | | | ● | ● | | | | | | ANACITHARA | | | ● | · | · | · | · | · | · | ● | † |
| | | | | | | | | | ● | · | · | ● | HETEROCITHARA | | | | | ● | · | · | · | · | ● | |
| | | | | | | ● | | | | | | | ETREMA | | | ● | · | ● | · | ● | · | ● | ● | † |
| | | | | | | | | | | | | | FILODRILLIA | | | | | ● | · | · | ● | · | ● | |
| | | | | | | ● | ● | | | | | | ETREMOPSIS | | | | | ● | · | · | ● | | | |
| | | | | | | | | | | | | | LIENARDIA | | | | | | | | | | ● | † |
| | | | | | | | | | | | | | ACRISTA | | | | | | | | | | ● | † |
| | | | | | | | | | | | | | HEMILIENARDIA | | | | | | | | | | ● | † |
| | | | | | | | | | | | | | PARACLATHURELLA | | | | | | | | | | ● | † |
| | | | | | | | | | | | | | PSEUDORAPHITOMA | | | | | | | | | | ● | † |
| | | | | | | | | | | | | | MACTEOLA | | | | | | | | | | ● | † |
| | | | | | | | | | | | | | EUCITHARA | | | | | | | ● | · | · | ● | † |
| | | | | | | | | | | | | | (DAPHNELLINAE) | | | | | | | | | | | |
| | | | | | | | | | | | ● | ● | DAPHNELLA | | | | | ● | · | · | · | · | ● | † |
| | | | | | | | | | | | | ● | ASPERDAPHNE | | | | | ● | · | · | · | · | ● | |
| | | | | | | | | | | | | | (ASPERTILLA) | | | | | | | | ● | · | ● | |
| | | | | | | | | | | | | | FENESTRODAPHNE | | | | | | | | ● | | | |
| | | | | | | | | | | | | ● | VEPRECULA | | | | | | | | ? | · | ● | † |
| | | | | | | ● | | | | | | | CRYPTODAPHNE | | | | | | | | | | | |
| | | | | | | ● | ● | | | | | | MAORIDAPHNE | | | | | | | | | | | |
| | | | | | | | | | | | | | HEMIDAPHNE | | | | | | | | | | ● | † |
| | | | | | | | | | | | | | EXOMILUS | | | | | | | | | | ● | |
| | | | | | | | | | | | | | PSEUDEXOMILUS | | | | | | | | ● | | | |
| | | | | | | ● | · | · | · | · | · | ● | NEPOTILLA | | | | | | | | | | ● | |
| | | | | | | | | | | | | ● | STILLA | | | | | | | | | | | |
| | | | | | | | | | | | ● | ● | ZENEPOS | | | | | | | | | | | |
| | | | | | | | | | | | | | PSEUDODAPHNELLA | | | | | | | | | | ● | † |
| | | | | | | | | | | | | | KERMIA | | | | | | | | | | ● | † |
| | | | | | | | | | | | | | EUCYCLOTOMA | | | | | | | | | | ● | † |
| | | | ● | · | ● | ● | ● | | | | | | RUGOBELA | | | ● | · | ● | | | | | | |
| | | | | | | ● | ● | | | | | | PUHA | | | | | | | | | | | |

| NEW ZEALAND | | | | | | | | | | | | | | AUSTRALIA | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| E | | | O | | | M | | | P | | | R | | E | O | M | | | | P | | | R | |
| | | | | | | ● | | | | | | | EUBELA | | | | | | | | | | | † |
| | | | | | | | | | | | | ● | XANTHODAPHNE | | | | | | | | | | | |
| | | | | | | | | | | | | | BENTHOFASCIS | | | | | | | | | | ● | |
| | | | | | | | | | | | | | TELEOCHILUS | | | ● | · | ● | | | | | | |
| | | | | | | | | | | | | | SYNGENOCHILUS | | | ● | | | | | | | | |
| | | | | | | | | | | | | | LITACHILUS | | | | | | | | | | ● | |
| | 10 | 10 | 2 | | 17 | 35 | 31 | 12 | 18 | 13 | 11 | 27 | | | | 28 | 2 | 35 | | 10 | 17 | 4 | 52 | |

The numerical totals of Turrid genera for the successive stages from Eocene to Recent for New Zealand and Australia illustrate several interesting points.

A good basis for comparison between faunas of the two countries exists only in respect to the Hutchinsonian and the Janjukian (Lower Miocene) and the Awamoan and the Balcombian (Middle Miocene).

The Australian material available for study is restricted to the marine horizons of South Australia, Victoria and Tasmania, an area more or less comparable in size and climatic range with that covered by the New Zealand Hutchinsonian and Awamoan. Also the four horizons cited are each represented by richly fossiliferous beds. The available material is thus considered reasonably representative of the respective faunas.

The Australian Janjukian has 28 genera, compared with 35 for the New Zealand Hutchinsonian, 52 for the Australian Recent fauna and 27 for the New Zealand Recent.

In New Zealand the drop from 35 Hutchinsonian to 27 Recent genera probably resulted from a cooling climate coupled with geographic isolation. Warm water genera such as *Gemmula, Inquisitor, Tomopleura, Microdrillia* and *Turridrupa* occurred in the New Zealand Lower Tertiary, but have since died out.

The comparison of 35 Balcombian genera with 52 for the Australian Recent is high when one considers that the Recent faunal figure covers the whole continent, whereas the Balcombian marine fauna is not known from Queensland or Northern Australia.

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## ACKNOWLEDGEMENTS.

The writer acknowledges the fine effort of Dr. Finlay, not only in forming this important collection, but also in expending upon it a considerable amount of preliminary work. The writer's thanks are due also to Dr. R. S. Allan, who freely handed to the writer series of specimens personally collected and representative of localities additional to those covered by the Finlay material.

## Subfamily TURRINAE.

### Genus TURRIS Bolten, 1798.

Type (s.d. Dall 1909): MUREX BABYLONIUS Gmelin Recent Indo-Pacific.

True *Turris* is elongate-fusiform with attenuated spire and long straight anterior canal. The deep sinus is on a rounded rib just above the peripheral carina and the protoconch is small, of 2½ smooth papillate whorls. Only slightly worn examples are available to me, but there appears to be no brephic stage of axials as in *Lophiotoma* and *Xenuroturris.*

A series of Australian middle Tertiary turrids conforms with this diagnosis of *Turris,* except that the anterior canal is relatively short and slightly twisted. The canal, however, is not suddenly truncated nor is the body-whorl basally angulate as in *Xenuroturris.* There seems to be no serious obstacle to the inclusion of these species in *Turris.*

Recent examples of *Turris* are restricted to the tropical Indo-Pacific. The genotype has been recorded from Cairns, North Queensland (Hedley 1922, p. 214).

#### Turris septemliratus (Harris (1897).

1897 *Pleurotoma septemlirata* Harris Cat. Tert. Moll. Brit. Mus., Pt. 1, p. 39, Pl. 2, figs. 10a-d.
1896 *Pleurotoma perarata* Tate MS.: Cossmann Ess. Pal. Comp. 2, p. 77.
1898 *Pleurotoma septemlirata: (perarata* as synonym) Tate, Proc. Roy. Soc. N.S.W. 31, p. 392.
1900 *Pleurotoma perarata:* Cossmann & Pissarro, Fauna Eoc. du Contentin 19, p. 24.

*Localities:* "Muddy Creek, Victoria: Eocene" (type); Muddy Creek, lower beds, Grice's Creek and Altona Shaft (Finlay coll.), Murghebolue (R. S. Allan) Victoria (Balcombian) Middle Miocene.

#### Turris selwyni (Pritchard, 1904).

1904 *Pleurotoma selwyni* Pritchard, Proc. Roy. Soc. Vict. 17, p. 326, Pl. 19, fig. 1.

*Localities:* Muddy Creek, lower beds (type); Balcombe Bay, Victoria (Finlay coll.) (Balcombian) Middle Miocene.

### Genus LOPHIOTOMA Casey, 1904.

Type (s.d. Woodring 1928): PLEUROTOMA TIGRINA Lamarck, Recent Indo-Pacific.

Shells of the general facies of *Turris,* but with a deep, narrow, "V"-shaped sinus on the flat or slightly concave peripheral carina. The protoconch is small, conical, of about 2½ whorls, followed by a half-whorl of brephic axials.

The (Balcombian) Middle Miocene species here ascribed to *Lophiotoma* agree fairly well except that the protoconch is more papillate of 2¼ whorls, with two or three brephic axials only, at its close. Also the bordering ridges of the concave peripheral carina are weakly crenulated by the narrow flaxuous axials. A resemblance to *Gemmula* results, but that genus has a tall narrow protoconch, the tip smooth, but the rest regularly axially costate. *Lophiotoma* occurs Recent in North Queensland (Hedley, 1922, p. 215, 216).

**Lophiotoma murndaliana (Tenison-Woods, 1879).**

1879 *Pleurotoma murndaliana* Ten.-Woods, Proc. Linn. Soc. N.S.W. 3, p. 226, Pl. 20, fig. 5.
1896 *Hemipleurotoma murndaliana:* Cossmann Ess. Pal. Comp. 2, p. 79.
1897 *Pleurotoma murndaliana:* Harris Cat. Tert. Moll. Brit. Mus., Pt. 1, p. 38.
1898 *Hemipleurotoma murndaliana:* Tate Proc. Roy. Soc. N.S.W. 31, p. 392.
1914 *Pleurotoma murndaliana:* Chapman Mem. Nat. Mus. Melb. 5, p. 19.

*Locality:* Muddy Creek, lower beds (type); Altona Bay (Finlay coll.) Victoria (Balcombian) Middle Miocene.

Dennant and Kitson (1903, p. 142) record this species from Limestone Creek, Glenelg River (Werrikooian), but it is probably a mistaken identification.

**Lophiotoma murrayana (Pritchard, 1904).**

1904 *Pleurotoma murrayana* Pritchard, Proc. Roy. Soc. Victoria 17, p. 335, fig. 10, Pl. 19.

*Locality:* River Murray Cliffs, near Morgan, South Australia (Balcombian) Middle Miocene.

Closely related to *murndaliana,* but more slender, with stronger peripheral crenulations and weaker subsidiary keels.

## Genus **XENUROTURRIS** Iredale, 1929.

Type (o.d.): X. LEGITIMA Iredale, Recent, North Queensland.

True *Turrinae* with tall spire, deep narrowly "V"-shaped sinus which is on the peripheral carina, or about two-thirds whorl height, where there is no clearly defined periphery. The protoconch is bluntly rounded, of two smooth whorls, followed by a half-whorl of brephic axials. The genus is near to *Lophiotoma,* which has a similar protoconch with brephic axials, but is discordant in having a truncated anterior canal and a subangulate base. The genus is of warm water Indo-Pacific distribution.

Iredale's *Clamturris* (1931), introduced for a Recent Australian new species, is based upon an aged specimen minus the protoconch. It strongly resembles *Xenuroturris,* although its author declared that it was of "different texture, being stout and hard."

**Xenuroturris tatei (Cossmann, 1896).**

1896 *Asthenotoma tatei* Cossmann, Ess. Pal. Comp. p. 173, Pl. 6, fig. 29.
1897 *Pleurotoma trilineata* Harris Cat. Tert Moll., Brit. Mus., Pt. 1, p. 40.
1898 *Asthenotoma tatei:* Tate, Proc. Roy. Soc., N.S.W. 31, p. 398.

*Localities:* "Australie du Sud," M. Bonnet Coll. = Muddy Creek, lower beds (type of *tatei):* "Hobson's Bay, Victoria" (type of *trilineata)* Balcombe Bay, Mornington; Shelford and Altona Shaft. (Finlay coll.) Victoria (Balcombian) Middle Miocene.

### Subgenus **VERUTURRIS,** n. subgen.

Type: V. QUADRICARINATUS n. sp. (Balcombian) Middle Miocene, Victoria.

A compact group of Australian Tertiary turrids, close to *Xenuroturris.* Same style of paucispiral protoconch with brephic axials, sinus "V"-

shaped at about two-thirds whorl height and subangulate base, but discordant in having a moderately long anterior canal. The canal is shorter than in *Turris* and *Lophiotoma,* but very different from the truncated canal of true *Xenuroturris.*

Since these long-canalled Xenuroturrids had a range from at least the (Balcombian) Middle Miocene to the (Adelaidean) Lower Mid. Pliocene, and were represented by five species, subgeneric segregation seems desirable.

**Key to Species of Veruturris.**

Shell large (50-55 mm.).
- Axials absent.
  - Spiral sculpture of dense spiral lineations ........ *subconcavus* (Harris)
  - Spiral sculpture of strong cords, 10 on spire whorls ...... *cochleatus* n.sp.

Shell small (15-26 mm.).
- Axials absent.
  - Primary spirals 4, middle pair stronger than those at sutures ............................ *quadricarinatus* n. sp.
  - Primary spirals 3, lower pair stronger, especially peripheral one ........................ *tomopleuroides* n. sp.
- Axial folds on upper half of whorls.
  - Primary spirals 2-3, on lower half of spire whorls ...... *bisculptus* n. sp.

## Xenuroturris (Veruturris) subconcavus (Harris, 1897).

1897 *Pleurotoma subconcava* Harris Cat. Tert. Moll. Brit. Mus., Pt. 1, p. 41, Pl. 3, figs. 2a-b.

*Locality:* "Merribee River," Victoria (type) Shelford and Lower Moorabool Valley, Victoria (Dennant and Kitson 1903, p. 96).

Harris' "Meribee River" is evidently a lapsus for Werribee River. It is unlikely, however, that this is the correct locality. If the specimens Dennant and Kitson list are the comparatively smooth shell figured by Harris, then the horizon for the species is probably (Janjukian) Lower Miocene.

Examples from Muddy Creek, lower beds (Balcombian), Middle Miocene, are sculptured with very strong spiral cords and represent a new species which is described below.

## Xenuroturris (Veruturris) cochleatus n. sp. Pl. 7, fig. 11.

Shell large, elongated, spire very tall. Protoconch of $2\frac{3}{4}$ smooth globose whorls plus a quarter whorl of brephic axials, practically the same as in *quadricarinatus,* but a little taller. Spire-whorls sculptured with strong narrowly rounded cords; one linear-spaced pair submargin the suture and a similar pair occur at the periphery, which comes at the apex of the narowly "V"-shaped sinus, and is situated at two-thirds whorl height. Between these pairs of cords is a deep concavity bearing a single weaker cord. Below the periphery there are five strong cords. On the body-whorl there are about 29 cords from the suture to the anterior end. The base is rendered subangulate by the sudden diminution of the strength of spirals after the first below the top of the aperture. Length of anterior canal half that of the entire aperture.

Height, 52 mm.; diameter, 14 mm.

*Localities:* Muddy Creek, lower beds (type); Altona Shaft (Finlay coll.); Clifton Beach, W. of Princetown (W. J. Parr), Victoria (Balcombian) Middle Miocene.

**Xenuroturris (Veruturris) quadricarinatus** n. sp. Pl. 1, fig. 5.

Shell small, resembling *X. tatei* except for the longer canal, and four spiral cords on the spire whorls instead of five. Protoconch blunt-tipped of $2\frac{1}{2}$ smooth globose whorls plus a half whorl of brephic axials. Spire-whorls with four evenly spaced strong rounded cords, middle pair stronger than other two, which are at the sutures. There are 1-4 fine spiral threads in the interspaces. A fifth cord emerges from just beneath the top of the aperture. Below this there are about 18 much weaker cords on the base and anterior end. The anterior canal is slightly more than half the height of the complete aperture. Sinus broadly "V"-shaped at its apex on the upper of the two median cords.

Height, 14.5 mm.; diameter, 4.2 mm.

*Localities:* Muddy Creek, lower beds (type); Altona Shaft (Finlay coll.) (Balcombian) Middle Miocene.

**Xenuroturris (Veruturris) tomopleuroides** n. sp. Pl. 1, fig. 3.

Shell small, with a prominent peripheral carina at one fourth whorl height, which gives the species a deceptive resemblance to *Tomopleura.* Protoconch broadly rounded, smooth, of 2 whorls, followed by three-fourths of a whorl of brephic axials. Spire-whorls with two spiral threads submargining upper suture, a moderately strong cord at three-fourths whorl height, and the peripheral carina, followed by a third strong spiral at the lower suture. A fourth strong spiral cord emerges from just beneath the top of the aperture. Below this there are about 18 much weaker cords on the base and anterior end. There are occasional interstitial threads on the spire whorls. Sinus broadly "V"-shaped, with its apex on the uppermost of the strong cords. There are weak gemmules on the sinus carina over the early whorls. Aperture and canal as in *quadricarinatus.*

Height, 17.5 mm.; diameter, 5.5 mm.

*Locality:* Abattoirs Bore, 400-500 ft., Adelaide, South Australia (Finlay coll.) (Adelaidean) Lower Mid. Pliocene.

**Xenuroturris (Veruturris) bisculptus** n. sp. Pl. 1, fig. 4.

Shell small, slender, with almost straight spire outlines. Sculptured in a curious manner—upper half of whorls with vertical fold-like axials, 17 per whorl, crossed by three spiral cords which are rendered nodulose by the axials—lower half of whorls with 2-3 heavy, closely spaced spirals. Base and anterior end with about 18 spirals, which are rendered rugose by moderately strong axial growth lines. Sinus "V"-shaped, not very deep, its apex on the upper half of the whorls. Length of anterior canal a little less than half total height of aperture. Protoconch broadly rounded, smooth, of two whorls, followed by almost a complete whorl of brephic axials.

Height, 13.9 mm.; diameter, 4.5 mm. (holotype).
Height, 26.7 mm.; diameter, 6.5 mm. (extra large, abnormally coiled).

*Locality:* Abattoirs Bore, 400-500 ft., Adelaide, South Australia (Finlay coll.) (Adelaidean) Lower Mid. Pliocene.

## Genus **OPTOTURRIS** n. gen.

Type: PLEUROTOMA OPTATA Harris (Balcombian) Middle Miocene, Victoria.

A curious Austral Miocene group with a paucispiral protoconch of $2\frac{1}{2}$ smooth whorls, top bluntly rounded, although the tip is small and asymmetric; last whorl steep sided, lightly convex, with no definite brephic stage; merges into curved axials of adult sculpture. In this last respect the protoconch conforms with that of *Turris,* as opposed to those of *Lophiotoma* and *Xenuroturris*. The sinus is broad, "U"-shaped, not very deep, and extends over almost half the shoulder, with its lower edge situated at the weak peripheral carina. The anterior canal is relatively short and straight. The position of the sinus and general facies of the weakly sculptured type species give a false resemblance to the New Zealand *Parasyrinx*. The second species, *paracantha,* is superficially reminiscent of another New Zealand group, *Cosmasyrinx*.

**Key to Species of Optoturris.**

Spiral sculpture of dense weak threads.
  Periphery rounded to subangulate, with median zone of
    4 stronger spirals.
   Crenulations on periphery of early whorls only.
    4-5 weak spirals below periphery ............... *optatus* (Harris)
    5-14 weak spirals below periphery .................... *editus* n. sp.
Spiral sculpture of moderately strong cords.
  Periphery narrowly rounded, bearing double carinae.
   Crenulations on periphery of all but last whorl.
    3-4 strong spirals below periphery ........ *paracanthus* (Ten. Wds.)

### **Optoturris paracanthus** (Tenison-Woods, 1877).

1877 *Pleurotoma paracantha* Ten.-Woods, Proc. Roy. Soc., Tas., for 1876, p. 105.
1898 *Bathytoma paracantha:* Tate, Proc. Roy. Soc. N.S.W. 31, p. 398.

*Localities:* Table Cape, Tasmania (type); Torquay, Victoria (Finlay coll.) (Janjukian) Lower Miocene.

### **Optaturris optatus** (Harris, 1897).

1897 *Pleurotoma optata* Harris. Cat. Tert. Moll. Brit. Mus., pt. 1, p. 44, Pl. 3, figs. 4a-b.

*Localities:* "Hobson's Bay, Victoria" (type) = Balcombe Bay; Muddy Creek, lower beds (Finlay coll.) Victoria (Balcombian) Middle Miocene.

### **Optoturris editus** n. sp. Pl. 7, fig. 3.

Related to *optatus,* but much narrower, with taller spire, longer canal, and weaker, more dense spiral threads. The periphery is sub-angulate and below the middle on the early whorls, but both the penultimate and the body-whorl are regularly convex except for a very weak subsutural concavity. On the spire-whorls there are 3-4 slightly stronger spirals submargining the suture and 4 more forming a peripheral zone. There are dense microscopic threads on the shoulder between the subsutural and peripheral spirals, and from 5-14 weak spirals between the peripheral zone and the lower suture. Fine, dense, evenly developed spiral threads cover the base and anterior end. The sinus is broad, but only moderately deep, as described above. Axials are in the form of comma-

shaped crenulations on the periphery of the early whorls, about 13 per whorl. The narrowness is accentuated in the holotype by abnormal loose coiling of the body-whorl.

Height, 25 mm.; diameter, 6.5 mm.

*Locality:* Grice's Creek, Victoria (Finlay coll.) (Balcombian) Middle Miocene.

## Genus **GEMMULA** Weinkauff, 1875.

Type (s.d. Cossmann 1896): PLEUROTOMA GEMMATA Reeve, Recent, "Gulf of Magdalena, California" may be Indo-Pacific.

A widely distributed genus in warm seas, with a range from Middle Eocene to the present. It is distinguished from true *Turris* by the gemmulate sinus rib and the narowly conic polygyrate protoconch, the tip smooth, remaining whorls axially costate. There are living Australian species, but the genus is not represented in the New Zealand Recent fauna.

### **Gemmula samueli** (Tenison-Woods, 1879).

1879 *Pleurotoma samueli* Ten.-Woods, Proc. Linn. Soc., N.S.W. 3, p. 226, Pl. 20, fig. 3.
1896 *Hemipleurotoma samueli:* Cossmann, Ess. Pal. Comp. 2, p. 79.
1897 *Pleurotoma samueli:* Harris, Cat. Tert. Moll., Brit. Mus., Pt. 1, p. 43.
1898 *Pleurotoma (Hemipleurotoma) samueli:* Tate, Proc. Roy. Soc., N.S.W., 31, p. 392.

*Localities:* Muddy Creek, lower beds; Altona Shaft (Finlay coll.); Victoria (Balcombian) Middle Miocene.

Resembles the New Zealand (Tahuian) Upper Eocene *waihaoensis* Finlay, 1924.

### **Gemmula gellibrandensis** Chapple, 1934.

1934 *Gemmula gellibrandensis* Chapple, Mem. Nat. Mus., Melb., 8, p. 163, Pl. 19, figs. 3 and 3a.

*Locality:* Princetown, ¾ m. W. of Gellibrand River, Victoria (Balcombian), Middle Miocene.

## Genus **MICANTAPEX** Iredale, 1936.

Type (o.d.): BATHYTOMA AGNATA Hedley & Petterd, 1906. Recent 250 fath. off Sydney, New South Wales.

*Bathytoma*-like shells which differ in having a blunt, smooth, pauci-spiral protoconch. The range in both New Zealand and Australia is Lower Miocene to Recent. Recent species are widely distributed in deep water, occurring in the Indian Ocean, Japan and West Indies. True *Bathytoma* occurs in the New Zealand Tertiary, but it has not been reported from Australia.

**Key to Species of Micantapex.**

Spiral sculpture of dense beaded lirations.
  21-27 beaded primary spirals on base.
    Peripheral fold weak, rounded .................... *decompositus* (Tate)
  15-17 beaded primary spirals on base.
    Peripheral fold strongly projecting.
      Shoulder lightly concave ........................ *fontinalis* (Tate)
      Shoulder deeply excavated ............................ *parri* n. sp.

Spiral sculpture of heavy scaly cords.
Shell elongate-biconic.
Subsutural fold bearing 2 beaded threads ...... *rhomboidalis* (T. Wds.)
Shell broadly-biconic
Subsutural fold very heavy, dominating sculpture ...... *perarmatus* n. sp.
Spiral sculpture. Broad, heavy, nodulose peripheral fold.
10 nodulose primary spirals on base .................... *pritchardi* (Tate)

### Micantapex fontinalis (Tate, 1894).

1893 *Dolichotoma fontinalis* Tate & Dennant (nomen nudum), Trans. Roy. Soc., S. Aust. 17, p. 221.
1894 *Genotia fontinalis* Tate, Proc. Roy. Soc. N.S.W. 27, p. 175, Pl. 10, fig. 4.
1896 *Bathytoma fontinalis:* Cossmann, Ess. Pal. Comp. 2, p. 103.
1897 *Bathytoma fontinalis:* Harris, Cat. Tert. Moll., Brit. Mus., Pt. 1, p. 51.
1898 *Genotia fontinalis:* Tate, Proc. Roy. Soc. N.S.W. 31, p. 398.

*Localities:* Spring Creek and Torquay, Victoria (Finlay coll.) (Janjukian) (Lower Miocene).

### Micantapex perarmatus n. sp. Pl. 7, fig. 1.

This is a broadly-biconic near relative to *rhomboidalis*. Apart from shape it is at once distinguished by the massive development of the subsutural fold, which dominates the sculpture, and the extremely deep canaliculate shoulder. The subsutural fold in *rhomboidalis* bears a pair of beaded threads and is always subsidiary to the peripheral fold.

Height, 35 mm.; diameter, 17.2 mm. (holotype of *perarmatus*).
Height, 35 mm.; diameter, 15 mm. (*rhomboidalis*).

*Locality:* Clifton Beach, 2 miles west of Princetown, Victoria (collected by W. J. Parr; Laws coll., type) (Balcombian?) Middle Miocene.

### Micantapex pritchardi (Tate, 1894).

1894 *Genotia pritchardi* Tate, Proc. Roy. Soc. N.S.W. 27, p. 175, Pl. 10, fig. 9.
1898 *Genotia pritchardi:* Tate, Proc. Roy. Soc. N.S.W. 31, p. 398.

*Locality:* Gippsland Lakes, Victoria (Kalimnan) Lower Pliocene. An Australian representative of the New Zealand *murdochi* line.

### Micantapex decompositus (Tate, 1894).

1893 *Dolichotoma decomposita* Tate & Dennant (nomen nudum) Trans. Roy. Soc. S. Aust. 17, p. 221.
1894 *Genotia decomposita* Tate, Proc. Roy. Soc. N.S.W. 27, p. 175, Pl. 10, fig. 8 (7c in error on plate).
1896 *Bathytoma gellibrandi* Cossmann, Ess. Pal. Comp. 2, p. 103.
1897 *Bathytoma decomposita:* Harris, Cat. Tert. Moll. Brit. Mus., Pt. 1, p. 50.
1898 *Genotia decomposita:* Tate, Proc. Roy. Soc. N.S.W. 31, p. 398.
1914 *Bathytoma decomposita:* Chapman, Mem. Nat. Mus. Melb. 5, p. 19.

*Localities:* Torquay (Janjukian) Lower Miocene; Gellibrand River (type); Balcombe Bay and Grice's Creek (Finlay coll.); Clifton Beach, W. of Princetown (W. J. Parr); Murgheboluc (R. S. Allan) Victoria (Balcombian) Middle Miocene.

Torquay and Grice's Creek examples are tall-spired, with straight outlines; Murgheboluc and Clifton Beach shells are wider, with bulging spire outlines. Larger series will be necessary to determine if these forms are constant.

### Micantapex rhomboidalis (Tenison-Woods, 1880).

1880 *Pleurotoma rhomboidalis* Ten.-Woods, Proc. Linn. Soc. N.S.W. 4, p. 10, Pl. 2, fig. 9.
1894 *Genotia angustifrons* Tate, Proc. Roy. Soc. N.S.W. 27, p. 175, Pl. 10, fig. 7.
1896 *Bathytoma atractoides* Tate MS. non Watson: Cossmann, Ess. Pal. Comp. 2, p. 103.
1897 *Bathytoma angustifrons:* Harris, Cat. Tert. Moll. Brit. Mus., Pt. 1, p. 49.
1898 *Genotia angustifrons:* Tate, Proc. Roy. Soc. N.S.W. 31, p. 398.
1898 *Genotia angustifrons:* Pritchard, Proc. Roy. Soc. Vict. 11, p. 100.
1914 *Bathytoma rhomboidalis:* Chapman, Mem. Nat. Mus. Melb. 5, p. 19.

*Localities:* Muddy Creek, lower beds (type); Balcombe Bay and Grice's Creek, Victoria (Finlay coll.) (Balcombian) Middle Miocene.

### Micantapex parri n. sp. Pl. 7, fig. 2.

Species large, about the size and build of *rhomboidalis,* but more closely related to *decompositus* and *fontinalis.* The sculpture consists of dense beaded lirations. *Decompositus* has the greater number (21-27 on the base), while both *fontinalis* and *parri* have fewer (15-17 on the base). In *parri* there is a heavy, rounded, projecting peripheral fold, and the shoulder is deeply excavated. In *decomposita* the peripheral fold is not very prominent, nor is the shoulder so deeply excavated. In *fontinalis* the periphery is narrowly angulate and the shoulder is broadly and very lightly concave.

In *parri* all the spiral cords are delicately beaded by the crossing of dense fine axial threads. These resolve into definite crenulations on the peripheral fold, 36-40 per whorl. On the spire-whorls there are about 18 spirals. The usual arrangement is 4 cords submargining the suture, 4 cords on the shoulder excavation, 3 cords on carina, 3 weak and very closely spaced threads immediately under the carina, 3 more distant cords below and 1, sometimes 2, weak threads just above lower suture.

Height, 40 mm.; diameter, 17.2 mm.

*Locality:* Altona Shaft, Victoria (Balcombian) Middle Miocene. (Collected by W. J. Parr; C. R. Laws coll., type.)

## Genus EPIDIRONA Iredale, 1931.

Type (o.d.): Epidirona hedleyi Iredale, Recent, New South Wales.

A genus of the *Turrinae,* with a superficial resemblance to *Drillia.* Protoconch small, smooth, bluntly rounded, of two whorls, without brephic axials. Sinus shallow to deep, "V"-shaped, situated on the rounded peripheral subangle. Spire tall, but the body-whorl is short, with a truncated, deeply-notched and twisted anterior canal; fasciole ridge-margined. Sculpture of spiral threads or cords with or without arcuate axials on the spire.

### Epidirona vardoni (Tate, 1899).

1899 *Surcula vardoni* Tate, Trans. Roy. Soc. S. Aust. 23, p. 108, Pl. 1, figs. 3a-b.

*Locality:* Murray Desert, Victoria (Janjukian?) Lower Miocene.

I have not seen this species, but according to Dr. Finlay's MS. notes it is "allied to the Abattoirs Bore *Epideira*" (i.e., *adelaidensis*).

### Epidirona suppressa (Finlay, 1927).

1904 *Pleurotoma selwyni laevis* Pritchard, Proc. Roy. Soc. Vict. 17, p. 328.
1927 *Epideira selwyni suppressa* Finlay, Trans. N.Z. Inst. 57, p. 516, nom. nov. for *laevis* Pritchard, 1904, non Bell, 1890.

*Locality:* ?Not definitely stated, but by inference either Muddy Creek, lower beds, or Balcombe Bay, Victoria (Balcombian) Middle Miocene.

Specimens from Abattoirs Bore, 400-500 ft. (Adelaidean) match Pritchard's figure, but actual comparison with the type is desirable.

### Epidirona adelaidensis (Ludbrook, 1941).

1941 *Bathytoma adelaidensis* Ludbrook, Trans. Roy. Soc. S. Aust. 65 (1) p. 97, Pl. 5, fig. 17.

*Locality:* Abattoirs Bore, 400-500 ft., Adelaide, South Australia (Finlay coll.) (Adelaidean) Lower Mid. Pliocene.

### ?Epidirona quoyi (Des Moulins, 1842).

Dennant and Kitson's record (1903, p. 142) of *Clavatula monile* Valenciennes from Limestone Creek, Glenelg River (Werrikooian), Upper Pliocene probably refers to the Recent *quoyi,* but I have not seen fossil material.

## Genus EPIDIRELLA Iredale, 1931.

Type (o.d.): HEMIPLEUROTOMA TASMANICA May, Recent, Tasmania.

The species listed below under this genus is not placed with confidence. It closely resembles *Pleurotoma xanthopaes* Watson in adult facies, having a strong peripheral bulge bearing blunt, strong nodules, a few strong, smooth spiral cords on the base, and a moderately long, slightly flexed, unnotched anterior canal. The protoconch in *sayceana* is small, smooth and globular, of two whorls. That of *xanthophaes* is described by its author as "apex coronated (?); it is somewhat rubbed, but seems to consist of 3 to 4 whorls." May described the apex of the related, if not identical, *Hemipleurotoma tasmanica* May, 1911, as "peg-like."

The moderately long unnotched anterior canal of *sayceana* precludes reference to *Epidirona,* which has a truncated, deeply-notched anterior canal. Reference of *sayceana* to *Micantapex* is another possibility, but the style of sculpture, sinus, and trend of the outer lip are more in accord with *Epidirella.* Pending more knowledge of the apical characters of these shells, *sayceana* is provisionally located in *Epidirella,* to which in adult facies it certainly bears considerable resemblance.

### ?Epidirella sayceana (Chapman, 1912).

1912 *Pleurotoma sayceana* Chapman, Proc. Roy. Soc. Vict. 25 (n.s.) p. 191, Pl. 12, fig. 7.

*Localities:* Lakes Entrance, Gippsland (type); Jemmy's Point, Victoria (Finlay coll.) (Kalimnan) Lower Pliocene.

## Subfamily TURRICULINAE.

### Genus COMITAS Finlay, 1926.

Type (o.d.): SURCULA OAMARUTICA Suter (= DRILLIA FUSIFORMIS Hutton) (Awamoan) Middle Miocene, New Zealand.

This is a group of *Turricula*-like species, best developed in the Middle Tertiary of New Zealand and Australia, but reaching Recent times in a solitary New Zealand species, *Pleurotoma trailli* Hutton 1873.

The genus differs from *Turricula* in having a larger and fewer whorled protoconch, papillate, of two smooth whorls; that of *Turricula* is minute, planorbid, of three whorls. *Comitas* is characterised also by having long axials and only weak submargining of the suture.

**Key to Species of Comitas.**

Whorls spirally sulcate.
  Whorls very slightly angled.
    Axials obsolete ..................................... *salebrosa* (Harris)

Whorls spirally ribbed and axially costate.
  Spiral primaries 2-3 on spire whorls.
    Axials 9 per whorl ........................... *wynyardensis* (Pritchard)
  Spiral primaries 4-5 on spire whorls.
    Axials 6-7 per whorl ............................. *pseudoclarae* n. sp.
    Axials 9 per whorl ......................... *crenularoides* (Pritchard)
    Axials 10 per whorl ............................. *torquayensis* n. sp.

**Comitas wynyardensis (Pritchard, 1896).**

1896 *Pleurotoma wynyardensis* Pritchard. Proc. Roy. Soc. Vict. 8, p. 109, Pl. 2, figs. 12, 13.
1942 *Comitas wynyardensis:* Powell, Bull. Auck. Inst. Mus. 2, p. 58.

*Localities:* Table Cape, Tasmania (type); Spring Creek, Victoria (Finlay coll.) (Janjukian) Lower Miocene.

**Comitas torquayensis** n. sp. Pl. 3, fig. 9.

Species very similar in general facies to *wynyardensis*, but with heavier axials and more numerous primary spirals. Axials bluntly rounded, 10 per whorl, extending half way across shoulder, but rapidly fading out on base. Primary spiral cords 4-5 on spire whorls, with a further 3 on body-whorl, at top of aperture. Shoulder with 10 fine spiral threads, two of which are on a narrow subsutural fold. Below the lowest primary spiral on the body-whorl the sculpture is abruptly reduced in strength and consists of about 34 fine linear-spaced threads. The primary spirals are slightly thickened where they cross the axials.

Height, 21 mm.; diameter, 7.8 mm.

*Locality:* Torquay, lower blue clays, Victoria (Finlay coll.) (Janjukian) Lower Miocene.

**Comitas crenularoides (Pritchard, 1896).**

1896 *Drillia crenularoides* Pritchard, Proc. Roy. Soc. Vic. 8 (n.s.) p. 110, Pl. 3, figs. 6 and 7.

*Locality:* Table Cape, Tasmania (Janjukian) Lower Miocene.

I have not seen this species, but from the original figure and description it appears to be allied to the foregoing new species. Pritchard's species differs, apparently, in having fewer, more broadly rounded, axial folds and a heavier subsutural fold.

**Comitas pseudoclarae** n. sp. Pl. 1, fig. 6.

Shell almost inseparable, in its adult facies, from *C. (Carinacomitas) clarae*, but with the typical two-whorled, smooth papillate protoconch of true *Comitas*. The only adult feature that readily separates *pseudoclarae* from *clarae* is the more rapidly contracted base, and resultant longer anterior canal.

Whorls sculptured with numerous narrow spiral cords, and dense weak lirations on the shoulder, as well as distant, low, broadly rounded axials, 6-7 per whorl, which rapidly become obsolete both on the shoulder and on the base. Spire-whorls with 10-12 lirae on the shoulder and 4-5 primary cords, with intermediates, from the peripheral angle to the lower suture. About 40 spirals on body-whorl from angle to anterior end. Spirals relatively strong both near the angle and at the anterior end.

Height, 14 mm.; diameter, 5 mm.

*Locality:* Torquay, Victoria (Finlay coll.) (Janjukian) Lower Miocene.

**Comitas salebrosa** (Harris, 1897).

1897 *Pleurotoma salebrosa* Harris, Cat. Tert. Moll., Brit. Mus., Pt. 1, p. 42, Pl. 3, figs. 3a-d.

1942 *Comitas salebrosa:* Powell, Bull. Auck. Inst. Mus. 2, p. 58.

*Localities:* "Hobson's Bay" (type) = Balcombe Bay; Altona Shaft (Finlay coll.) Victoria (Balcombian) Middle Miocene.

## Subgenus **CARINACOMITAS** Powell, 1942.

Type (o.d.): PLEUROTOMA CLARAE Ten.-Woods.

This subgenus was provided for Miocene species from both Australia and New Zealand, in which the normal bulbous protoconch of *Comitas* is replaced by a more depressed paucispiral two-whorled protoconch with the second whorl sharply carinate. The New Zealand species is *subcarinapex* Powell 1942 (Hutchinsonian) Lower Miocene.

**Comitas (Carinacomitas) aldingensis** n. sp. Pl. 1, fig. 7.

Shell much smaller and more heavily sculptured than *clarae*. The protoconch is broadly rounded, rather erect, of two smooth whorls, which are strongly carinated throughout. The species approaches the New Zealand Recent *Anticomitas vivens* Powell 1942, but in that genus the whole protoconch is very depressed and flattened on top. The anterior canal, also is much shorter in the Recent species.

Whorls bluntly angled just below the middle, sculptured with prominent broadly rounded axials, rapidly fading out on shoulder and not extending over base, 10 per whorl. First post-nuclear whorl develops a spiral thread above the carina, soon followed by another below the carina. These spirals form the three primary keels of subsequent whorls. On the body-whorl two further strong spirals develop near the top of the aperture. There are about 26 narrow spirals on the body-whorl, these becoming gradually smaller and closer spaced towards the

anterior end. The shoulder is smooth except for a fine line submargining the suture. The three main spirals develop vertically compressed tubercles where they cross the axials.

Height, 6.8 mm.; diameter, 2.9 mm. (holotype).
Height, 7.75 mm.; diameter, 3 mm.

*Locality:* Aldinga, lower beds, South Australia (Finlay coll.) (Janjukian) Lower Miocene.

**Comitas (Carinacomitas) clarae** (Tenison-Woods, 1880).

1880 *Pleurotoma clarae* Ten.-Woods, Proc. Linn. Soc. N.S.W. 4, p. 11, Pl. 3, fig. 11.
1896 *Borsonia clarae:* Cossmann, Ess. Pal. Comp. 2, p. 98.
1897 *Pleurotoma clarae:* Harris, Cat. Tert. Moll. Brit. Mus., Pt. 1, p. 43.
1906 *Drillia clarae:* Cossmann, Ess. Pal. Comp. 7, p. 224.

*Localities:* Muddy Creek, lower beds (type); Balcombe Bay; Altona Shaft, Victoria (Finlay coll.) (Balcombian) Middle Miocene.

## Genus **INSOLENTIA** Finlay, 1926.

Type (o.d.): Pleurotoma pareoraensis Suter (Awamoan) Middle Miocene, New Zealand.

A Tertiary group allied to *Turricula,* but with a very different protoconch, which is polygyrate, narrowly conic, of three to four smooth whorls, followed by a wider whorl with rather distant, arcuate axial riblets. The shells are slender, fusiform, with a moderately deep sinus on the shoulder.

The Australian (Janjukian) Lower Miocene species is the only known occurrence of the genus outside New Zealand.

**Insolentia johnstoni** (Tenison-Woods, 1877).

1877 *Pleurotoma johnstoni* Tenison-Woods, Proc. Roy. Soc. Tas. for 1876, p. 105.
1942 *Insolentia johnstoni:* Powell, Bull. Auck. Inst. Mus. 2, p. 63.

*Localities:* Table Cape, Tasmania (type); Torquay, upper beds; Spring Creek, upper beds, Victoria (Finlay coll.) (Janjukian) Lower Miocene.

Victorian examples in Dennant collection are labelled *Pleurotoma* aff. *johnstoni,* but I have no topotypes of *johnstoni* for comparison.

## Genus **APIOTOMA** Cossmann, 1889.

Type (o.d.): Pleurotoma pirulata Deshayes, Eocene, Paris Basin.

The Victorian *bassi* with its long, gradually tapered body-whorl and loose coiling, is closely similar to the genotype, which is from the Parisian Eocene. The species *janjukiensis* and its allies present a very different appearance in being closely coiled and of fusiform shape, with a long, narrow anterior canal. These extremes are bridged to some extent by the very slender fusiform *granti* and a related new species. The depth and width of the sinus varies also, being broad and shallow in the *bassi-granti* series, but narrow and deep in *janjukiensis.* The closer coiling and presence of a strong subsutural fold occasions this difference in *janjukiensis.*

The paucispiral protoconch, common to them all, shows insufficient divergence to warrant generic or subgeneric segregation.

**Key to Species of Apiotoma.**

Protoconch narrowly conical, with a projecting, slightly asymmetric tip.
  Shell slender; loosely coiled whorls. Like *Zemacies*.
    Body-whorl long, very gradually tapered.
      Peripheral nodules 14-15 per whorl ................ *bassi* Pritchard
      Peripheral nodules absent ......................... *pritchardi* n. sp.
  Shell very slender, with attenuated spire. Like *Colus*.
    Body-whorl quickly contracted; long canal.
      Peripheral nodules absent ...................... *granti* (Pritchard)
      Peripheral nodules on early whorls .................. *chapplei* n. sp.

Protoconch globose, asymmetric tip, not projecting.
  Shell rather broadly fusiform; closely coiled whorls.
    Body-whorl quickly contracted; long canal.
      Peripheral nodules absent .................. *janjukiensis* (Chapple)
      Peripheral nodules 12-14 per whorl ............ *balcombensis* n. sp.

## **Apiotoma bassi** Pritchard, 1904.

1904 *Apiotoma bassi* Pritchard: Proc. Roy. Soc. Vict. 17, p. 328, Pl. 19, fig. 11.
1914 *Apiotoma bassi:* Chapman, Mem. Nat. Mus. Melb. 5, p. 19.

*Locality:* Cape Otway, near Point Flinders, Victoria (Finlay coll.) (Janjukian) Lower Miocene.

## **Apiotoma janjukiensis** (Chapple, 1934).

1934 *Turris janjukiensis* Chapple, Mem. Nat. Mus. Melb. 8, p. 163, Pl. 19, figs. 2, 2a.

*Localities:* Bird Rock Cliffs, Spring Creek, Torquay, Victoria (Finlay coll.) (Janjukian) Lower Miocene.

## **Apiotoma balcombensis** n. sp. Pl. 7, fig. 10.

Species evidently the linear descendant of *janjukiensis*, differing from it chiefly by the presence of regular axials on the broadly rounded peripheral bulge. Also the subsutural fold bears two spiral cords; that of *janjukiensis* has a single thread only, defining its lower edge. Protoconch globose, of 2½ smooth whorls, with small asymmetric tip. Spiral sculpture of 6-7 narrow but sharply raised cords, extending over the peripheral bulge to the lower suture, about 40 on body-whorl from the periphery to the end of the canal. There are 6-7 distinct spiral lirations on the shouder or sinus area. In *janjukiensis* the shoulder spirals increase from 4-8, but are much weaker. Axials broad, fold-like, restricted to the peripheral bulge, 12 per whorl, strongest on later whorls. Sinus rather deep, constricted by the subsutural fold.

Height, 31.3 mm.; diameter, 10.6 mm.

*Locality:* Balcombe Bay, Victoria (Finlay coll.) (Balcombian) Middle Miocene.

## **Apiotoma pritchardi** n. sp. Pl. 3, fig. 7.

Species close to *bassi*, but without nodules, fewer and stronger, less wavy spiral threads, and a more quickly contracted base. Protoconch globose-conic, smooth, of 2½ whorls, tip small, asymmetric, slightly projecting. Whorls distinctly angled above the middle. Sculpture of rounded, distinct, narrow spiral cords, those on shoulder about half the strength of those below the periphery, 4-7 on shoulder, 5-12 below

periphery, and about 48 on the body-whorl from below the periphery to end of anterior canal. Sinus broad, occupying width of shoulder, not very deep.

Height, 20 mm.; diameter, 6 mm.

*Locality:* Torquay, lower and upper (type) beds, Victoria (Finlay coll.) (Janjukian) Lower Miocene.

**Apiotoma granti** (Pritchard, 1904).

1904 *Pleurotoma granti* Pritchard, Proc. Roy Soc. Vict. 17, p. 336, Pl. 19, fig. 3.

*Locality:* Muddy Creek, lower beds, Victoria (Finlay coll.) (Balcombian) Middle Miocene.

**Apiotoma chapplei** n. sp. Pl. 3, fig. 6.

Species attenuated-fusiform, near to *granti,* but with fewer, more sharply raised spirals, almost smooth shoulder, and blunt peripheral nodules, 11 per whorl on the first three post-nuclear whorls. Protoconch rather narrowly conic, of 2½ smooth whorls, tip slightly asymmetric. Whorls distinctly angled at the middle. Spiral sculpture of sharply raised, rather distant narrow cords, one strong, submargining suture, one weak, just above peripheral angle, two strong, at periphery, and two almost as strong, below. About 36 spirals on body-whorl, widely spaced on upper part of base, weaker and narrowly spaced on anterior canal. The shoulder is smooth except for obscure spiral striations and arcuate growth lines which define the broad, moderately deep sinus.

Height, 18.2 mm.; diameter, 5 mm.

*Localities:* Balcombe Bay (type); Muddy Creek, lower beds, Murgheboluc (R. S. Allan) Victoria (Finlay coll.) (Balcombian) Middle Miocene.

The Murgheboluc specimen has more closely spaced basal ribbing. Further material may prove it to be separable.

Genus **ZEMACIES** Finlay, 1926.

Type (o.d.): Z. ELATIOR (Finlay (Hutchinsonian) Lower Miocene, New Zealand.

A genus of the *Turriculinae* closely allied to *Apiotoma* Cossmann, 1889, of the Parisian Eocene, but of more slender shape, with drawn out loosely coiled whorls, and a tall, regularly conic protoconch of 4-5 smooth glossy whorls.

A most significant specimen in the Finlay collection from Torquay, Victoria (Janjukian) is superficially similar in adult facies to the Janjukian *Apiotoma bassi* (Pritchard), but has the *Zemacies* protoconch. *Apiotoma* is unknown from the New Zealand fauna, but *Zemacies* has a long range from the (Wangaloan) Upper Cretaceous to the (Opoitian) Lower Pliocene. It would appear probable that *Zemacies* is the older stock and that the divergence of *Apiotoma* from it took place early in the Australian Tertiary.

**Zemacies inexpectata** n. sp. Pl. 7, fig. 8.

Shell superficially similar to *bassi,* slender, with loosely coiled whorls, but finer spiral sculpture and absence of axials. Regular rest periods give the appearance of flexuous obsolescent axial folds, apparent only on the carina of the later whorls. Whorls distinctly angled just above

the middle. Suture faintly but rather broadly submargined. Spire-whorls with 4 to 5 weak, closely spaced threads on the subsutural band, rest of shoulder with microscopic dense striations, and 12-22 weak, closely spaced threads from the periphery to the lower suture. Body-whorl incomplete in sole example. The protoconch is typical, tall, narrowly conic, of 4 smooth whorls, with a tiny apex.

Height (body-whorl incomplete), 24.2 mm. (estimated) 30 mm.; diameter, 10 mm.

*Locality:* Torquay, lower beds, Victoria (Finlay coll.) (Janjukian) Lower Miocene.

## Subfamily COCHLESPIRINAE.

### Genus CORONASYRINX n. gen.

Type: C. VENUSTA n. sp. (Balcombian) Middle Miocene, Victoria.

This new genus is provided for an Australian Middle Tertiary group which is of similar build to the West Indian *Ancistrosyrinx*, but differs considerably in both the protoconch and in the form of the sinus. In *Ancistrosyrinx* the protoconch is slender, of 1½ smooth, convex whorls, and the sinus occupies only the upper half of the shoulder, which is bisected by a lamellate ridge. Below this ridge there is a second indentation or pseudo-sinus. In *Coronasyrinx* the protoconch is subcylindrical, of two whorls, which are subequal in width, the first with an immersed tip, flattened on top due to strong median angulation of both whorls. The sinus occupies the upper two thirds of the shoulder; its upper arm ascends almost vertically to the suture, but the lower arm is arcuately produced forwards. There is no lamellate ridge on the shoulder. "*Ancistrosyrinx*" *terebralis* (Lamarck) Eocene, France, is remarkably similar to *Coronasyrinx* in adult features, but has a protoconch more like that of *Ancistrosyrinx*.

**Coronasyrinx venusta** n. sp. Pl. 1, fig. 1.

Slender, fusiform, with tall spire and long, straight, anterior canal. Whorls keeled and coronated medially by strong upcurved tubercles, 18 per whorl. Shoulder with a subsutural band of recurrently oblique oval gemmules, and two similar but much weaker bands immediately above the coronated keel. Between the subsutural and lower gemmulate bands the shoulder is smooth except for weakly defined sinus growth curves. From the keel to the lower suture there are four strong, closely spaced gemmulate spiral bands. On the body-whorl there are 27 gemmulate spirals which extend right to the tip of the anterior canal. One gemmulate cord much stronger than the rest emerges from the lower suture and encircles the base.

Height, 14.8 mm.; diameter, 5.8 mm.

*Localities:* Torquay, upper beds (Janjukian) Lower Miocene; Balcombe Bay (type) (Finlay coll.) (Balcombian) Middle Miocene, Victoria.

**Coronasyrinx semiplana** n. sp. Pl. 1, fig. 2.

Shell of similar proportions to *venusta*, but with a more flange-like keel, bearing weaker tubercles, not upcurved, about 20 per whorl. There are no spirals on the spire-whorls, and the basal spirals are plain, not

gemmulate. The body-whorl has a strong, sharply raised keel emerging from the suture and encircling the base. There are no spirals above this keel, but 21 plain cords from below it to the end of the anterior canal. Sinus and protoconch as in *venusta*.

Height, 9.6 mm.; diameter, 3.9 mm.

*Locality:* Aldinga, lower beds, South Australia (Finlay coll.) (Janjukian) Lower Miocene.

## Subfamily CONORBIINAE.

### Genus **CONORBIS** Swainson, 1840.

Type (monotypy): CONUS DORMITOR Sowerby (Bartonian) Upper Eocene, England.

### **Conorbis atractoides** Tate, 1890.

1890 *Conorbis atractoides* Tate, Trans. Roy. Soc. S. Aust. 13, pt. 2, p. 200.

*Locality:* "Clayey greensand, Adelaide-Bore, South Australia" (Janjukian?) Lower Miocene.

I have not seen topotypes of this species, but there is an allied new species with fewer spirals from Abattoirs Bore 400-500 feet, Adelaide (Adelaidean) Lower Mid-Pliocene. In the Finlay collection there is a single worn example not good enough for description.

### Genus **AUSTROTOMA** Finlay, 1924.

Type (o.d.): BATHYTOMA EXCAVATA Suter (Hutchinsonian) Lower Miocene, New Zealand.

The finding of Australian Lower Miocene representatives of this characteristic New Zealand Tertiary genus is of considerable interest, particularly as there is close resemblance between the Table Cape, Tasmanian, species (Janjukian) and the New Zealand genotype (Hutchinsonian). Both stages are recognised as representing the Lower Miocene in their respective countries.

*Austrotoma* differs from *Belophos* in details of the protoconch, the presence of a subsutural fold and usually the dominance of the spiral sculpture over the axial. The protoconch is polygyrate of 4-5 whorls, with a minute globular tip, the first three whorls being smooth and the remainder bearing strong, flat-topped, spiral cords crossed by thin axials towards its close. The anterior canal is very short and deeply notched.

### **Austrotoma inexpectata** n. sp. Pl. 7, figs. 6, 7.

Shell ovate-biconic, with short spire, three-fourths height of aperture. Whorls rounded except for a moderately broad, shallowly excavated shoulder. The narrowly rounded shoulder angle is at the middle of the spire-whorls, but above the greatest peripheral convexity of the body-whorl. The surface is sculptured with closely spaced spiral threads and cords crossed on the early spire-whorls by numerous narrowly rounded axial folds. There are no axials on the body-whorl apart from irregular growth lines. There is a narrow subsutural fold. Spire-whorls with 10 fine, spaced threads on the shoulder, 4 to 5 primary cords with intermediates from the shoulder angle to the lower suture and about 32

on the body-whorl from below the shoulder angle. The cords are weak over the upper half of the base, but quite strong below. The axial folds on the early whorls number from 26 to 28. The protoconch is quite typical, as described above. The anterior canal is very short and deeply notched. Fasciole margined by a sharp ridge.

Height, 22.5 mm.; diameter, 11.5 mm. (holotype).
Height, 28.5 mm.; diameter, 13 mm. (paratype).

*Locality:* Table Cape, Tasmania (Finlay coll.) (Janjukian) Lower Miocene.

**Austrotoma janjukiensis** n. sp. Pl. 3, fig. 1.

Species similar to *inexpectata*, but without axial folds on the spire. The primary spirals are heavier, more broadly rounded, with a thread in each interspace over most of the base. In *inexpectata* the spirals are obsolescent on the upper half of the base. There is a moderate subsutural fold. Spire-whorls with 8 spaced, spiral threads on the shoulder, 5 strong rounded cords from shoulder angle to lower suture and about 14 primary cords on the body-whorl. Spiral threads, one per interspace over the upper half of the base, increasing to three below, and finally crowding the neck just above the fasciole. The spire is not much less than the height of the aperture.

Height, 26.5 mm.; diameter, 12.1 mm.

*Locality:* Spring Creek, upper beds, Victoria (Finlay coll.) (Janjukian) Lower Miocene.

## Genus **BELOPHOS** Cossmann, 1901.

Type (o.d.): BELA WOODSI Tate (Janjukian) Lower Miocene, Tasmania.

An Austral group of the *Conorbiinae*, nearest allied to *Austrotoma*, but differing from it both in details of the protoconch and in the dominance of the axial sculpture. The protoconch is polygyrate of 4-5 whorls, tip minute, globular and smooth, last two whorls reticulated by thin spirals and stout axials. The anterior canal is very short and deeply notched, while the shoulder is regularly concave without a subsutural fold. So far as is known the genus is monotypic.

**Belophos woodsi** (Tate, 1888).

1888 *Bela woodsi* Tate, nom. nov. for *Cominella cancellata* Ten.-Woods, Trans. Roy Soc. S. Aust. 10, pp. 147 & 173.
1901 *Belophos woodsi:* Cossmann, Ess. Pal. Comp. 4, p. 163.

*Localities:* Table Cape, Tasmania (type); Bird Rock Cliffs, Torquay; Spring Creek; Victoria (Finlay coll.) (Janjukian) Lower Miocene.

## Genus **BELATOMINA** Powell 1942.

Type (o.d.): BELA PULCHRA *Tate* (Balcombian) Middle Miocene, Victoria.

Moderately large biconic shells with dense axial and spiral sculpture, poorly defined shoulder, very weakly notched anterior canal and a large, very depressed, blunt, smooth-tipped protoconch of $1\frac{1}{2}$ whorls. The genus is known only from the Tertiary of Victoria and Tasmania, (Janjukian) Lower Miocene to (Balcombian) Middle Miocene.

Comparisons between this genus and the related *Liratomina*, *Belophos* and *Austrotoma* are given in my work on the New Zealand *Turridae* (Powell, 1942, p. 72).

**Key to Species of Belatomina.**

Subsutural ridge prominent—deeply excavated below.
  Axials broad, fold like—about 27 on penultimate.
    Spiral cords and lirae undulating over axials......*tenuisculpta* (T. Wds.)
Subsutural ridge slight—weakly excavated below.
  Axials narrow and crisp—about 36 on penultimate.
    Spiral cords and lirae undulating over axials............*pulchra* (Tate)
    Spiral cords stronger than axials—regularly
      clathrate and gemmulate........................*clathrata* n.sp.

## **Belatomina tenuisculpta** (Tenison-Woods, 1877).

1877 *Daphnella tenuisculpta* Ten.-Woods, Proc. Roy. Soc. Tas. for 1876, p. 106.
1898 *Bela tenuisculpta:* Tate, Proc. Roy. Soc. N.S.W. 31, p. 393.

*Localities:* Table Cape, Tasmania (type); Table Cape, and Torquay, Victoria (Janjukian), Lower Miocene. (Finlay coll.).

Dennant and Kitson (1903, p. 142) record this from Limestone Creek, Glenelg River (Werrikooian) Upper Pliocene; but it is probably a mistaken identification.

## **Belatomina pulchra** (Tate, 1888).

1888 *Bela pulchra* Tate, Trans. Roy. Soc. S. Aust. 10, p. 173.
1897 *Daphnella pulchra* : Harris, Cat. Tert. Moll. B.M. Pt. 1, p. 62.
1898 *Bela pulchra:* Tate, Proc. Roy. Soc. N.S.W. 31, p. 393 (as syn. of *Daphnella tenuisculpta* Ten. Woods).

*Localities:* Muddy Creek lower beds (type); Muddy Creek, lower, and Balcombe Bay, Victoria (Balcombian) Middle Miocene. (Finlay coll.).

## **Belatomina clathrata** n. sp. Pl. 7, fig. 9.

1896 *Bela pulchra:* Cossmann Ess. Pal. Comp. 2, p. 90, Pl. 6, figs. 10-11 (not of Tate 1888).

Ovate, aperture half height of shell. Whorls 5, including typical blunt smooth-tipped protoconch of $1\frac{1}{2}$ whorls. Axials narrow, crisp and flexuous, 36 on penultimate, crossed by slightly stronger but equally narow crisp primary cords, seven on penultimate. Points of intersection betwen axials and spirals delicately gemmulate. Three or four axial growth lines and a similar number of spirals delicately cancellate the rectangular interspaces of the primary sculpture. There is a slight depression below the weak subsutural fold. On the body-whorl there are thirteen primary spirals, and the axials extend over the base to the neck. Anterior canal short, broadly open and very weakly notched. There are six closely spaced spiral lirae on the neck. Subsutural sinus broadly and shallowly arcuate.

Height, 17 mm.; diameter, 8 mm. (holotype).

*Locality:* Muddy Creek, lower beds, Victoria (Finlay coll.) (Balcombian) Middle Miocene.

## Genus **LIRATOMINA** Powell, 1942.

Type (o d.) : BELA SCULPTILIS Tate, 1888 (Balcombian) Middle Miocene, Victoria.

Moderately large, fusiform-turreted shells with crisp spiral and axial sculpture, the spirals predominant. Protoconch large, smooth and rounded, of $1\frac{1}{2}$ whorls, followed by a half-whorl of closely spaced, fine brephic axials. Post-nuclear whorls are rounded, with a concave shoulder, but no subsutural fold.

There is superficial resemblance to both *Belophos* and *Austrotoma*, but the protoconchs are quite dissimilar. The genus is known only from the Tertiary of Victoria, South Australia, and Tasmania (Janjukian) Lower Miocene, to Adelaidean) Middle Pliocene.

#### Key to Species of Liratomina.

Axials obsolete—fine growth lines only.
    Shoulder prominent.
        Spiral cords strong, wide-spaced, without intermediates.
            Penultimate with 6 spiral cords below shoulder .. *crassilirata* (Tate)
        Spiral cords broad but weak; linear interspaces.
            Penultimate with about 8 spiral cords below shoulder *adelaidensis* n. sp.
    Shoulder slight.
        Spiral cords narrow, crisp, not prominent.
            Penultimate with about 12 spiral cords below shoulder *sculptilis* (Tate)
Axials distinct, fold-like, extending from shoulder to lower suture.
    Shoulder prominent.
        Spiral cords narrow, crisp, rather prominent.
            Penultimate with 6-8 spiral cords below shoulder .... *intertexta* n. sp.

### **Liratomina sculptilis** (Tate, 1888).

1888 *Bela sculptilis* Tate, Trans. Roy. Soc. S. Aust. 10, p. 173.
1898 *Bela sculptilis:* Tate, Proc. Roy. Soc. N.S.W. 31, p. 393.
1897 *Daphnella sculptilis:* Harris, Cat. Tert. Moll. Brit. Mus., Pt. 1, p. 61.

*Locality:* Muddy Creek, lower beds (type) (Balcombian) Middle Miocene; Table Cape, Tasmania (Finlay coll.) (Janjukian) Lower Miocene.

A single example from Table Cape compared with a single topotype shows the former to differ slightly from the latter in having a more deeply excavated shoulder and more sharply raised sculpture. Series of both will be necessary to determine if these observations apply constantly.

### **Liratomina intertexta** n. sp. Pl. 7, fig. 4.

Moderately large, fusiform, with turreted spire; whorls 7, including typical, large, smooth, blunt protoconch of $1\frac{1}{2}$ whorls. Aperture about half or a little less than half the height of shell. Axials distinct, fold-like, flexuous, extending from shoulder angle to lower suture, becoming obsolete over base, 21 on penultimate. Shoulder broad, deeply concave. Suture with a weak fold below it. Spiral sculpture consisting of four sharply raised narrow cords with some weaker intermediates on the shoulder or posterior sinus area, and six to eight rather strong, narrow, sharply raised cords with intermediates, extending from the shoulder angle to the lower suture. There are about twenty-four primaries and

some intermediates on the body-whorl and base. The fasciole bears about nine spaced, narrow, spiral lirations. The whole surface is crowded with fine crisp axial growth lines. The general appearance of the sculpture resembles that of a woven basket.

Height, 35 mm. (estimated); diameter, 14 mm. (paratype) (Dr. C. R. Laws coll.).

Height, 44 mm. (estimated); diameter, 16.5 mm. (holotype).

*Locality:* Torquay, upper beds, Victoria (Finlay coll.) (Janjukian) Lower Miocene.

### Liratomina crassilirata (Tate, 1888).

1888 *Bela crassilirata* Tate, Trans. Roy Soc. S. Aust. 10, p. 173, Pl. 4, fig. 7.
1896 *Pseudotomo crassilirata:* Cossmann, Ess Pal. Comp. 2, p. 146.
1897 *Daphnella crassilirata:* Tate, Cat. Tert. Moll. Brit. Mus., Pt. 1, p. 62.
1898 *Bela crassilirata:* Tate, Proc. Roy. Soc. N.S.W. 31, p. 393.

*Localities:* Muddy Creek, lower beds (type); Balcombe Bay, Victoria (Finlay coll.) (Balcombian) Middle Miocene.

### Liratomina adelaidensis n. sp. Pl. 7, fig. 5.

Moderately large, fusiform, prominently shouldered, with broad but deeply excavated shoulder; whorls 6½, including typical protoconch of 1½ whorls. Aperture half height of shell. Whorls polished, but with distinct slightly raised spiral sculpture. Axials obsolete except for fine growth lines. Shoulder, or posterior sinus area, concave, with seven to nine spiral threads and some intermediates. Seven or eight broad, flattened spiral cords with weakly incised linear grooves between them, extending from the shoulder angle to the lower suture. Spirals sub-obsolete on the body-whorl, but becoming stronger and wider spaced on the lower part of the base. Fasciole with three strong, medially placed spiral cords, separated from the base by a prominent narrow ridge. Anterior canal deeply notched.

Height, 32.6 mm.; diameter, 16 mm. (holotype).
*Locality:* Abattoirs Bore, 400-500 feet, Adelaide, South Australia (Finlay coll.) (Adelaidean) Lower Mid. Pliocene.

The species has a strong superficial resemblance to *Austrotoma.*

## Subfamily CLAVINAE.

### Genus INQUISITOR Hedley, 1918.

Type (o.d.): PLEUROTOMA STERRHA Watson, Recent, North Queensland.

### Inquisitor detritus Ludbrook, 1941.

1941 *Inquisitor detritus* Ludbrook, Trans. Roy. Soc. S. Aust. 65, p. 98, Pl. 5, fig. 18.

*Locality:* Abattoirs Bore, 400-500 ft., Adelaide, South Australia (Finlay coll.) (Adelaidean) Lower Mid. Pliocene.

The protoconch is conical, somewhat flattened, of two smooth whorls, but a small tip. It does not fit readily into either *Inquisitor* with its polygyrate, narrowly conical protoconch, or into *Pseudoinquisitor,* which has a bluntly rounded protoconch of 2-2½ smooth whorls.

## Genus **PSEUDOINQUISITOR** Powell, 1942.

Type (o.d.): P. PROBLEMATICUS Powell (Awamoan) Middle Miocene, New Zealand.

A group of *Inquisitor*-like species, but with a smooth, bluntly rounded, paucispiral protoconch of $2\frac{1}{2}$ whorls. The New Zealand range of the genus is Lower and Middle Miocene, but it possibly goes back to the (Bortonian) Middle Eocene. In Australia the genus occurs in the (Balcombian) Middle Miocene, (Kalimnan) Lower Pliocene, and reaches Recent times in *Inquisitor coriorudis* Hedley, 1922, from 300 fath. off Sydney.

**Key to Species of Pseudoinquisitor.**

Shell small (11-15 mm.), narrow.
  Spirals strong, 4-7 on spire whorls.
    Axials 7 per whorl, subobsolete on body-whorl ...... *oblongulus* (Harris)
Shell larger (16-21 mm.), broader.
  Spirals fine.
    5-9 on spire whorls. Axials 10 ...................... *delicatulus* n. sp.
  Spirals coarse.
    3 on spire-whorls. Axials 14-15 ...................... *trinervis* n. sp.
    3-5 on spire-whorls. Axials 13 .................... *gippslandensis* n. sp.
    6-8 on spire-whorls. Axials 14 ..................... *scabriculus* n. sp.

### **Pseudoinquisitor oblongulus** (Harris, 1897).

1897 *Drillia oblongula* Harris, Cat. Tert. Moll., Brit. Mus., Pt. 1, p. 56, Pl. 3, f. 7a, b.
1898 *Buchozia oblongula:* Tate, Proc. Roy. Soc. N.S.W. 31, pp. 382, 393.

*Locality:* Muddy Creek, lower beds, Victoria (Finlay coll.) (Balcombian) Middle Miocene.

### **Pseudoinquisitor trinervis** n. sp. Pl. 3, fig. 3.

Shell robust, strongly axially and spirally sculptured. Axials broadly rounded, vertical, 14-15 per whorl, extending from peripheral angle to half way across base. Spiral cords moderately strong, 3 on spire-whorls, from periphery to lower suture, and 13 on body-whorl and base. Subsutural fold distinct over early spire-whorls, but later becoming obsolete. Shoulder deeply concave. Periphery just above middle.

Height, 19.5 mm.; diameter, 7 mm.

*Locality:* Jemmy's Point, Victoria (Finlay coll.) (Kalimnan) Lower Pliocene.

Dennant and Kitson's (1903, p. 137) record of the New Zealand "*Drillia wanganuiensis*" from Gippsland Lakes is based no doubt upon one or more of the Kalimnan species here described.

### **Pseudoinquisitor gippslandensis** n. sp. Pl. 3, fig. 5.

Species similar to *trinervis,* but proportionately broader, with slightly telescoped spire-whorls, more spirals, and a stronger, more persistent subsutural fold. Axials broadly rounded, vertical, 13 per whorl, extending over base. Spiral cords strong, 3-5 on spire-whorls, 16 on body-whorl and base. Subsutural fold strong, shoulder deeply concave. Periphery at two-thirds whorl height.

Height, 16 mm.; diameter, 6.25 mm.

*Locality:* Gippsland Lakes, Victoria (Finlay coll.) (Kalimnan) Lower Pliocene.

**Pseudoinquisitor scabriculus** n. sp. Pl. 3, fig. 2.

Shell rather large. Axial and spiral sculpture both well developed, subsutural fold weak to obsolescent. Periphery above middle, rounded, shoulder deeply concave. Axials broadly rounded, 14 per whorl, subobsolete over base, crossed by coarse linear-spaced spiral cords, 6-8 on spire-whorls and about 21 on body-whorl and base. The concave shoulder bears indistinct spiral threads.

Height, 21 mm.; diameter, 7.8 mm.

*Locality:* Gippsland Lakes, Victoria (Finlay coll.) (Kalimnan) Lower Pliocene.

**Pseudoinquisitor delicatulus** n. sp. Pl. 3, fig. 4.

Differs from all the above species in the numerous delicate spirals and obliquely flexuous, more narrowly crested axials. Periphery just above middle of whorl height; axials planed off on top by broadly excavated shoulder, and rapidly fading out over base. Subsutural fold moderately broad, but not heavy. Spirals linear-spaced, 5-9 per whorl, and about 35 on body-whorl and base.

Height, 17.2 mm.; diameter, 6.5 mm.

*Locality:* Gippsland Lakes, Victoria (Finlay coll.) (Kalimnan) Lower Pliocene.

## Genus **VIXINQUISITOR** Powell, 1942.

Type (o.d.): Drillia vixumbilicata Harris (Balcombian) Middle Miocene, Victoria.

This is another aberrant group of the *Inquisitor* assemblage, characterised by a distinctive protoconch, which is subcylindrical, of 2½ smooth, glossy whorls, the first bulbous, somewhat flattened above, and wider and more convex than the almost straight-sided succeeding whorl. The protoconch passes abruptly into the adult sculpture with just a few faint sinuous growth lines. Apart from a very narrow subsutural margining the adult shell is closely similar in facies to that of both *Inquisitor* and *Pseudoinquisitor*.

The protoconch of *Inquisitor* is smooth, polygyrate, and narrowly conical, and that of *Pseudoinquisitor* smooth, bluntly rounded, paucispiral, of 2½ whorls.

**Vixinquisitor vixumbilicatus** (Harris, 1897).

1897 *Drillia vixumbilicata* Harris, Cat. Tert. Moll. Brit. Mus., Pt. 1, p. 56, Pl. 3, f. 8a, b.

1898 *Drillia vixumbilicata:* Tate, Proc. Roy. Soc. N.S.W. 31, p. 392.

*Localities:* Muddy Creek, lower beds (type) Balcombe Bay, Victoria (Finlay coll.) (Balcombian) Middle Miocene.

## Genus **INTEGRADRILLIA** Powell, 1942.

Type (o.d.): Drillia integra Tenison-Woods (Balcombian) Middle Miocene, Victoria.

In adult facies the genus closely resembles *Pseudoinquisitor,* except that the subsutural fold is obsolete or very weak, and the parietal callus pad slightly constricts the sinus, rendering it subtubular. The proto-

conch is the chief differentiating character, being bluntly conic, of two smooth whorls, the initial coil lateral, and terminated by a thin, flexuous varix, concave above and produced forwards below. There are several variciform threads just prior to the terminal varix.

**Integradrillia integra** (Tenison-Woods 1880).

1880 *Drillia integra:* Ten.-Woods, Proc. Linn. Soc. N.S.W. 4, p. 11, Pl. 3, fig. 4.
1878 *Drillia integra:* Tate, Proc. Roy. Soc. N.S.W. 31, p. 392.
1896 *Drillia integra:* Cossmann, Ess. Pal. Comp. 2, p. 84.

*Localities:* Muddy Creek, lower beds; Balcombe Bay and Altona Bay, Victoria (Finlay coll.) (Balcombian) Middle Miocene.

**Integradrillia** n. sp.

There is a second species of *Integradrillia* at Balcombe Bay, but no adult examples are available for description. Three half-grown examples exhibit a more pronounced peripheral angle, weaker spiral sculpture, especially on the shoulder, and wider-spaced axials.

## Genus **MICRODRILLIA** Casey, 1903.

Type (s.d. Cossmann, 1906): PLEUROTOMA COSSMANNI Meyer (= P. MEYERI Aldrich). Upper Eocene, Jackson, Mississippi, U.S. America = ACROBELA Thiele 1925.

The sinus area is deeply sunken between heavy subsutural and peripheral keels, the protoconch is polygyrate, of five whorls, tip smooth, remainder regularly axially costate. The tropical Australian genus *Turridrupa* resembles *Microdrillia*, but has a fewer-whorled protoconch and a single strong spiral cord on the sinus area. *Microdrillia* is of wide Tertiary and Recent distribution (Powell 1942, p. 116).

The Australian Recent *Drillia commentica* Hedley, 1915, *Pleurotomella fastosa* Hedley, 1907, and *Turridrupa pertinax* Hedley, 1922, belong to *Microdrillia*. In New Zealand there is one Tertiary species, *Microdrillia pakaurangia* Powell, 1942 (Hutchinsonian) Lower Miocene, and one *Turridrupa, maoria* Powell, 1942 (Taranakian) Upper Miocene.

**Microdrillia steiroides** (Chapman, 1928).

1928 *Filodrillia steiroides* Chapman, Rec. Geol, Surv. Vict. 5 (1), p. 121, Pl. 9, fig. 57.

*Localities:* Balcombe Bay, Mornington (type); Sorrento Bore, 1,340 feet; Muddy Creek, lower beds; Grice's Creek, Victoria (Finlay coll.) (Balcombian) Middle Miocene.

## Genus **SPLENDRILLIA** Hedley, 1922.

Type (o.d.): DRILLIA WOODSI Beddome, Recent, S.E. Australia.

The genus is tall-spired, with prominent axial sculpture, stopped at an excavated shoulder. Surface smooth or striate. Subsutural fold present, usually strongly developed. Protoconch paucispiral, bluntly-rounded, smooth. Outer-lip with a slight "stromboid"-notch. Parietal callus-pad heavy. Sinus on shoulder, moderate to deep, rounded, sometimes subtubular.

Distribution in both Southern Australia and New Zealand, Lower Miocene to Recent.

**Key to Species of Splendrillia.**

Shell small (9-11 mm.); slender.
  Spirals incised over all post-nuclear whorls.
  Spirals distinct; shoulder deeply concave.
    Axials broadly rounded, almost vertical, 10 per whorl .. *trevori* (T.-Wds.)
  Spirals weak; shoulder very shallow.
    Axials narrowly rounded, very oblique, 10-11 per whorl .... *formosa* n. sp.
Shell larger (12-16 mm.); moderately broad.
  Spirals confined to neck.
    Axials subobsolete over body-whorl, very oblique,
      12 per whorl ............................ *trucidata* (Ludbrook)
  Spirals strongly incised over all post-nuclear whorls.
    Axials broadly rounded, almost vertical, 12 per whorl .... *adelaidae* n. sp.

## Splendrillia trevori (Tenison-Woods, 1879).

1879 *Drillia trevori* Ten.-Woods, Proc. Linn. Soc. N.S.W. 3, p. 227.
1897 *Drillia trevori:* Harris, Cat. Tert. Moll. Brit. Mus., pt. 1, p. 55.

*Localities:* Muddy Creek, lower beds (type); Altona Bay, Victoria (Finlay coll.) (Balcombian) Middle Miocene.

## Splendrillia formosa n. sp. Pl. 2, fig. 5.

Shell small, slender, tall-spired, sculptured with narrowly-rounded, very oblique axials, 10-11 per whorl, obsolescent on last whorl. Surface covered with incised spirals, 12 on spire-whorls and about 26 on body-whorl, base, and neck. From the middle of the base to the anterior end the spirals become increasingly deeper and wider-spaced, cutting the surface into quite strong rounded cords. Subsutural fold weak, narrow, and flattened. Shoulder very steep, broad, and very shallow, scarcely indenting the lightly convex whorl outlines. Aperture narrow; parietal callus-pad heavy; posterior sinus deep, subtubular.

Height, 10.5 mm.; diameter, 3.9 mm.

*Locality:* Muddy Creek, lower beds, Victoria (Finlay coll.) (Balcombian) Middle Miocene.

## Splendrillia trucidata (Ludbrook, 1941).

1941 *Austrodrillia trucidata* Ludbrook, Trans. Roy. Soc. S. Aust. 65 (1), p. 98, Pl. 5, fig. 20.

*Locality:* Abattoirs Bore, 400-500 ft., Adelaide, South Australia (Finlay coll.) (Adelaidean) Lower Mid. Pliocene.

## Splendrillia adelaidae n. sp. Pl. 2, fig. 6.

Shell moderately large, proportionately broad, strongly axially and spirally sculptured as in the Recent *harpularia*. Axials vertical, broadly rounded, 12 per whorl, tops sharply planed off at peripheral angle, but extended weakly over base. Surface covered with deeply incised spirals, six on spire-whorls and about 26 on body-whorl, base and neck. Subsutural fold strong, flattened. Shoulder deeply concave. Parietal callus-pad heavy; sinus broadly rounded, moderately deep.

Height, 11.3 mm.; diameter, 4.15 mm.

*Locality:* Abattoirs Bore, 400-500 ft., Adelaide, South Australia (Finlay coll.) (Adelaidean) Lower Mid. Pliocene.

**Splendrillia harpularia** (Des Moulins, 1842).

Dennant and Kitson (1903, p. 142) record this Recent South Australian species from Limestone Creek, Glenelg River (Werrikooian) Upper Pliocene.

## Genus SYNTOMODRILLIA Woodring, 1928.

Type (o.d.): DRILLIA LISSOTROPIS Dall, Recent, West Indies, 73-290 fath.

The genus consists of small-sized species resembling *Splendrillia*, but without a subsutural fold and having the axials continuous from suture to suture. Most Austral members differ from the West Indian series in the subangulate base, but this feature is considered of no taxonomic import.

The Australian range is (Janjukian) Lower Miocene to (Adelaidean) Middle Pliocene.

The only New Zealand member is *S. waiauensis* Powell, 1942 (Hutchinsonian) Lower Miocene, but the subgenus *Hauturua* Powell, 1942, ranges from the Hutchinsonian to Recent, New Zealand.

### Key to Species of Syntomodrillia.

Spiral sculpture confined to neck.
  Peripheral angle scarcely apparent.
    Axials 15-16 per whorl ............................ *ludbrookae* n. sp.
  Peripheral angle weak.
    Spirals on neck distinct.
      Axials 11 per whorl, connected by peripheral thread .. *circinata* n. sp.
      Axials 8-10 per whorl, no peripheral thread
        *decemcostata* (Ludbrook)
    Spirals on neck obsolescent.
      Axials 12-13 per whorl .......................... *obsoleta* n. sp.
  Peripheral angle bluntly rounded.
      Axials narrowly rounded, 21-24 per whorl .......... *venusta* n. sp.
  Peripheral angle sharply defined.
      Axials prominent, most numerous on body-whorl;
        10-13 per whorl .................. *sandleroides* (T.-Wds.)
Spiral sculpture over all post-nuclear whorls.
  Peripheral angle above middle.
      Axials narrow, 17-19 per whorl ...................... *compta* n. sp.
  Peripheral angle at four-fifths whorl height.
      Axials narow, 22-23 per whorl .................... *complexa* n. sp.

**Syntomodrillia sandleroides** (Tenison-Woods, 1877).

1877 *Pleurotoma sandleroides* Ten.-Woods, Proc. Roy. Soc. Tas. for 1876, p. 104.
1898 *Drillia sandleroides* Tate, Proc. Roy. Soc. N.S.W. 31, p. 392.
1919 *Pleurotoma sandleroides:* May, Proc. Roy. Soc. Tas. for 1918, p. 72, Pl. 10, fig. 13.

*Locality:* Table Cape, Tasmania (type); Torquay, Victoria (Finlay coll.) (Janjukian) Lower Miocene.

**Syntomodrillia circinata** n. sp. Pl. 2, fig. 12.

Species very similar to *obsoleta,* but much larger, axials more erect, and connected across the shoulder-angle by a weak thread; five moderately strong spirals on the neck. Axials 11 per whorl.

Height, 6 mm.; diameter, 2.5 mm.

*Locality:* Torquay, upper beds, Victoria (Finlay coll.) (Janjukian) Lower Miocene.

**Syntomodrillia venusta** n. sp. Pl. 2, fig. 7.

Shell glossy, whorls bluntly angled above middle. Sculpture consisting of distinct, narrow, rounded, flexuous axials, 21-24 per whorl, extending from upper suture over base to the neck, which bears six distinct spiral threads. Outer lip terminated by a heavy hollow varix. This labial varix restricts the depth of the posterior sinus, which is abnormally shallow for the genus.

Height, 7.9 mm.; diameter, 3 mm.

*Localities:* Balcombe Bay, Mornington (type); Altona, Victoria (Finlay coll.) (Balcombian) Middle Miocene.

**Syntomodrillia complexa** n. sp. Pl. 2, fig. 8.

Species related to *compta,* but with a much higher shoulder angle, situated at about four-fifths whorl height. Axials narrowly rounded, extending from upper suture to the upper part of the base, 22-23 per whorl. Spirals low, flattened, weak cords, separated by linear grooves, 10 from shoulder angle to lower suture, none on shoulder and about 27 on body-whorl and base. Outer lip terminated in a rounded hollow varix.

Height, 8.9 mm.; diameter, 3.6 mm.

*Locality:* Altona Bay, Victoria (Finlay coll.) (Balcombian) Middle Miocene.

**Syntomodrillia compta** n. sp. Pl. 2, fig. 9.

Shell similar to *venusta,* but spirally sculptured over all post-nuclear whorls. Whorls very slightly angled above middle. Shoulder with four or five very indistinct spiral threads; shoulder angle to lower suture with 4-7 distinct rounded spiral cords; body-whorl and base with about 22 moderately strong cords plus a few weak spirals on the neck. Axials narrowly rounded, but strong, 17-19 per whorl, extending from upper suture over the base, but fading out before reaching the neck. Outer lip terminating in a rounded hollow varix.

Height, 9 mm.; diameter, 3.9 mm.

*Localities:* Balcombe Bay, Mornington (type); Altona (Finlay coll.) Victoria (Balcombian) Middle Miocene.

Differs from *complexa* in having fewer axials and spiral threads overriding the axials, instead of spirals, separated by grooves, between the axials.

**Syntomodrillia obsoleta** n. sp. Pl. 2, fig. 11.

Much smaller than *sandleroides,* has weaker axials and obsolescent spirals. Shell small, glossy; whorls $5\frac{1}{2}$, including typical smooth, globular protoconch of two whorls. Post-nuclear whorls sculptured with

moderately strong, but narrow, obliquely flexuous axials, which extend from the upper suture and fade out about the middle of the base; 12-13 per whorl; 12 on penultimate in holotype. The axials are slightly thickened at the weak peripheral angle, which is just above the middle. There is no spiral sculpture apart from four obsolescent threads on the anterior end.

Height, 5.3 mm.; diameter, 1.9 mm.

*Locality:* Balcombe Bay, Mornington, Victoria (Finlay coll.) (Balcombian) Middle Miocene.

### **Syntomodrillia decemcostata** (Ludbrook, 1941).

1941 *Austrodrillia decemcostata* Ludbrook, Trans. Roy. Soc. S. Aust. 65 (1), p. 98, Pl. 5, fig. 19.

*Locality:* Abattoirs Bore, 400-500 ft., Adelaide, South Australia (Finlay coll.) (Adelaidean) Lower Mid. Pliocene.

### **Syntomodrillia ludbrookae** n. sp. Pl. 2, fig. 10.

Whorls very lightly convex, peripheral angle scarcely apparent, defined only by a slight thickening of the axials at about the middle. Axials narrow-crested, oblique, flexuous over body-whorl, fading out on middle of base, 15-16 per whorl. Anterior end with 5 distinct spiral threads.

Height, 7 mm.; diameter, 2.7 mm.

*Locality:* Abattoirs Bore, 400-500 ft., Adelaide, South Australia (Finlay coll.) (Adelaidean) Lower Mid. Pliocene.

## Subgenus **HAUTURUA** Powell, 1942.

Type (o.d.): H. VIVENS Powell, Recent, New Zealand.

The subgenus resembles *Syntomodrillia* except for the axials, which are reduced almost to pointed peripheral tubercles. From *Splendrillia* it is distinguished by the smooth shell without spirals, the absence of a subsutural fold, and a more or less subangulate base.

### **Syntomodrillia (Hauturua) exuta** n. sp. Pl. 2, fig. 13.

Shell moderately large, proportionately broad, strongly axially tuberculate, but entirely lacking spiral sculpture, even on the neck. Axials broadly rounded, 13-14 per whorl, stopped at the angulate-periphery, which is situated at the middle of the whorls; becoming obsolete before reaching base. Subsutural fold obsolete. Shoulder broadly and shallowly excavated. Parietal callus-pad very heavy.

Height, 15.6 mm.; diameter, 6 mm.

*Locality:* Gippsland Lakes, Victoria (Finlay coll.) (Kalimnan) Lower Pliocene.

## Genus **MAUIDRILLIA** Powell, 1942.

Type (o.d.): MANGILIA PRAECOPHINODES Suter (Awamoan) Middle Miocene, New Zealand.

A group of small Austro-Neozelanic "Drillias" with a globular protoconch of two smooth whorls. Simple outer lip with a broad, rather

shallow, sinus, occupying most of the shoulder. No parietal callus-pad and very shallow, oblique anterior notch. Sculpture axial and spiral. Subsutural cord present or absent.

In Australia the genus ranges from the (Janjukian) Lower Miocene to Recent.

**Key to Species of Mauidrillia.**

Spirals numerous, 4-7 on spire-whorls.
  Shell narrow.
    Periphery angulate.
      Axials narrow, very numerous, reticulating surface *consutilis* (T.-Wds.)
      Axial tubercles on carina of early whorls only ...... *partinoda* n. sp.
      Axial ribs on spire-whorls only ........... *pullulascens* (T.-Wds.)
    Periphery sharply carinate.
      Axials thread-like, serrating carina, 25 per whorl .. ..*serrulata* n. sp.
      Axials broadly rounded, knobs on carina, 11 per whorl ......................... *torquayensis* n. sp.
  Shell broad.
    Periphery broad rounded fold.
      Axials nodulose on carina ..................... *intumescens* n. sp.
Spirals sparse, 3 on spire-whorls.
  Shell narrow.
    Periphery angulate.
      Axials nodulose at spiral intersections ........... *trispiralis* n. sp.
      Axials vertically compressed tubercles on the carina *aldingensis* n. sp.
      Axials strong on carina only, very oblique.
        Basal spirals distant linear groove ................ *secta* n. sp.

## **Mauidrillia pullulascens** (Tenison-Woods, 1877).

1877 *Pleurotoma pullulascens* Ten.-Woods, Proc. Roy. Soc. Tas. for 1876, p. 104.
1898 *Drillia pullulascens:* Tate, Proc. Roy. Soc. N.S.W. 31, p. 392.
1919 *Pleurotoma pullulascens:* May, Proc. Roy. Soc. Tas. for 1918, p. 72, Pl. 10, fig. 12.

*Localities:* Table Cape, Tasmania (type); Torquay, Victoria (Finlay coll.) (Janjukian) Lower Miocene.

## **Mauidrillia torquayensis** n. sp. Pl. 4, fig. 7.

Species superficially similar to *aldingensis,* but more likely derived from *pullulascens,* from which it differs in being broader, with a stronger, more persistent peripheral angulation and strong axial knobs. Subsutural fold indistinctly defined on early whorls only. Four fine spirals on shoulder. Five to six stronger cords from angle to lower suture on spire-whorls, about 25 on body-whorl, base, and anterior end. Interspaces slightly more than width of spirals. Axials strong at periphery, but becoming obsolete before reaching either suture.

Height, 9.1 mm.; diameter, 3.9 mm.

*Locality:* Torquay, Victoria (Finlay coll.) (Janjukian) Lower Miocene.

## **Mauidrillia partinoda** n. sp Pl. 4, fig. 5.

Species close to *pullulascens,* but with the axials reduced to weak tubercles on the carina of the first two to three post-nuclear whorls only, 11 per whorl. Spiral sculpture consisting of a subsutural margining

cord, two weaker cords on the shoulder, the moderately strong peripheral cord at the middle of the whorls, 2 to 3 weaker cords below it, plus 8 on the base and a further 8 linear-spaced threads on the anterior end. The whorls are only slightly angled.

Height, 8.4 mm.; diameter, 3 mm.

*Locality:* Balcombe Bay, Mornington, Victoria (Finlay coll.) (Balcombian) Middle Miocene.

**Mauidrillia trispiralis** n. sp. Pl. 4, fig. 9.

Shell very slender, sculptured with relatively few strong spirals which are rendered nodulose at the axial intersections. Subsutural fold strong, 2 to 3 threads on shoulder; peripheral carina and two cords below it, all equally strong. About 19 cords on body-whorl from periphery to the anterior end. The holotype exhibits abnormal sculpture on the front of the body-whorl, due to a shell injury and its subsequent repair. Axials 13 per whorl, producing nodulation where they cross the three main spirals. Body-whorl crossed by numerous axial riblets which render the spirals weakly crenulate. The absence of strong axial nodulation on the body-whorl may be due to the shell injury already mentioned.

Height, 9.9 mm.; diameter, 3.5 mm.

*Locality:* Gellibrand River, Victoria (Finlay coll.) (Janjukian) Lower Miocene.

**Mauidrillia consutilis (Tenison-Woods, 1880).**

1880 *Pleurotoma consutilis* Ten.-Woods, Proc. Linn. Soc. N.S.W. 4, p. 9, Pl. 2, fig. 5.
1896 *Asthenotoma consutilis:* Cossmann, Ess. Pal. Comp. 2, p. 105.
1897 *Pleurotoma consutilis:* Harris, Cat. Tert. Moll. Brit. Mus., pt. 1, p. 41.
1898 *Asthenotoma consutilis:* Tate, Proc. Roy. Soc. N.S.W. 31, p. 398.
1941 *Filodrillia turrita* Chapple, Mem. Nat. Mus. Vict. 12, p. 121, Pl. 14, fig. 4.

*Localities:* Muddy Creek, lower beds (type); Balcombe Bay and Altona Bay (Finlay coll.) (Balcombian) Middle Miocene.

**Mauidrillia serrulata** n. sp. Pl. 4, fig. 8.

Species close to *consutilis,* but with a sharply projecting double carina which is delicately serrated by the crossing of numerous axial threads. Serrations about 25 per whorl. Subsutural fold bearing two spiral threads, three on shoulder, two heavier linear-spaced cords forming the carina, and 2 to 5 beneath it. On the body-whorl, from the carina to the anterior end, there are 19 narrow, flat-topped spiral cords, with interspaces double their width.

Height, 9 mm.; diameter, 4 mm. (holotype).
Height, 12 mm.; diameter, 4.6 mm. (Altona Bay).

*Localities:* Balcombe Bay (type) and Altona Bay, Victoria (Finlay coll.) (Balcombian) Middle Miocene.

**Mauidrillia aldingensis** n. sp. Pl. 4, fig. 6.

A robust, strongly sculptured species with the axials developed into vertically compressed tubercles where crossed by the carina. Suture bordered below by a narrow, sharp cord, three spiral threads on the shoulder, followed by the peripheral carina and two equally strong cords

below it. On the body-whorl the development of intermediates increases the spirals to seven from the carina to the lower suture; there are about 29 spirals from the carina to the anterior end. Axials 13 per whorl, plus numerous fine axial threads which obliquely fenestrate the shoulder spirals.

Height, 9.5 mm.; diameter, 3.8 mm.

*Locality:* Aldinga, lower beds, South Australia (Finlay coll.) (Janjukian) Lower Miocene.

**Mauidrillia secta** n. sp. Pl. 4, fig. 10.

Differing from all other species in the deeply incised lines which cut the surface into broad, rounded, spiral folds. Two or three linear grooves below periphery on spire-whorls, nine on body-whorl and base, plus five linear-spaced weaker cords on the anterior end. Subsutural fold moderate. Shoulder without spiral sculpture. Axials very oblique, planed off above, 13 per whorl, strongest at periphery, where they are sharply tubercular, but becoming obsolete before reaching lower suture.

Height, 12 mm.; diameter, 4.5 mm.

*Locality:* Aldinga, lower beds, South Australia (Finlay coll.) (Janjukian) Lower Miocene.

**Mauidrillia intumescens** n. sp. Pl. 4, fig. 4.

Shell large for genus; distinguished from all other Australian members by the broad, heavy peripheral fold. A moderately broad subsutural fold, on the early spire-whorls only. Surface of spire crowded with spiral threads, 3 on subsutural fold, 4-8 on broadly concave shoulder, 5-6 on peripheral fold, and 1 or 2 stronger cords below it. Six primary cords on base, plus intermediate threads and 8 closely spaced threads on the anterior end. Axials strongly nodulose on the peripheral fold, 14 per whorl; weakly nodulose on the subsutural fold, but elsewhere they are narrow and weak.

Height, 18 mm.; diameter, 7.5 mm.

*Locality:* Gippsland Lakes, Victoria (Finlay coll.) (Kalimnan) Lower Pliocene.

## Genus **TOMOPLEURA** Casey, 1904.

Type (o.d.): Pleurotoma nivae Philippi, Recent, Formosa = Cryptomella Finlay 1924.

In my "New Zealand Recent and Fossil Mollusca of the Family Turridae" (1942, pp. 110-113) I recognized two groups of the spirally keeled "Drillias" in New Zealand: *Tomopleura* with a tall, narrow, polygyrate protoconch of 4-5 whorls, and *Maoritomella* nov. provided for the series, with a paucispiral, broad, dome-shaped or globular protoconch of only two whorls.

*Tomopleura* has a wide Tertiary and Recent range. In New Zealand it occurs with certainty from the (Duntroonian) Upper Oligocene to the (Awamoan) Middle Miocene, and possibly back to the (Wangaloan) Upper Cretaceous.

The genus is represented in Australia by the (Kalimnan) Lower Pliocene *dilectoides*, the (Adelaidean) Middle Pliocene species described below, and the Recent New South Wales to Queensland species figured by Hedley (1922, Pl. 42, fig. 6) as *Asthenotoma subtilinea* Hedley.

**Tomopleura dilectoides** (Chapman & Gabriel, 1914).

1914 *Pleurotoma (Drillia) dilectoides* Chapman & Gabriel, Proc. Roy. Soc. Vict. 26 (n.s.), p. 327.

*Localities:* Gippsland Lakes (Kalimnan) Lower Pliocene (type) (Finlay coll.); Mallee Bore 6, 114-150 ft., and Bore 8, 180-199 ft. (Chapman).

**Tomopleura ludbrookae** n. sp. Pl. 2, fig. 14.

Shell much more slender than either *dilectoides* or the Recent *subtilinea;* body-whorl broadly arcuate, only slightly angulate, and with more numerous, closer-spaced spirals. Spire-whorls with the main carina just below the middle, two spirals submargin the suture, upper one a weak thread, lower one a strong cord. Two to three threads on the shoulder or sinus area, and two strong cords below the peripheral carina. About 23 spirals on body-whorl, 6 linear-spaced on anterior end. Interspaces on base 2 to 3 times width of cords. All interspaces delicately sculptured with closely-spaced flexuous axial threads. The base is more gradually tapered and the anterior end not so sharply pointed as in *dilectoides.*

Height, 14.9 mm.; diameter, 4.6 mm.

*Locality:* Abattoirs Bore, 400-500 ft., Adelaide, South Australia (Finlay coll.) (Adelaidean) Lower Mid. Pliocene.

Dennant and Kitson (1903, p. 142) recorded *Pleurotoma violacea* Hinds from Limestone Creek, Glenelg River (Werrikooian) Upper Pliocene. This is possibly either the above new species or the Recent *subtilinea* Hedley, but I have not seen specimens.

## Genus **MAORITOMELA** Powell, 1942.

Type (o.d.): PLEUROTOMA ALBULA Hutton, Recent, New Zealand.

Protoconch paucispiral, globular of two smooth whorls, followed by a half whorl of brephic axials.

The New Zealand range is (Duntroonian) Upper Oligocene to Recent. In Australia the genus occurs from the (Janjukian) Lower Miocene to Recent. Recent Australian members are *Drillia dilecta* Hedley, 1903, and *Filodrillia steira* Hedley, 1922.

**Key to Species of Maoritomella.**

Spire-whorl sculpture.
- Peripheral carina at middle of whorls.
  - 4 weak spirals above carina, 2 stronger ones below .... *balcombensis* n. sp.
- Peripheral carina at one-fourth whorl height.
  - 4 weak spirals above carina, 1 heavy one below ........... *nutans* n. sp.
- Peripheral angle obsolete, whorls rounded.
  - 6 evenly developed spiral cords ...................... *equispiralis* n. sp.

**Maoritomella equispiralis** n. sp. Pl. 2, fig. 16.

Shell slender, with lightly convex whorls; spire outlines almost straight; no peripheral carina. Spiral cords strong, more or less of equal development, 4 to 5 on early whorls, 6 from penultimate onward. About 25 spirals on body-whorl from suture to anterior end. Axial threads crowd the interspaces and actually cross and cancellate the weaker spirals.

Height, 12.5 mm.; diameter, 4.2 mm.

*Locality:* Torquay, Victoria (Finlay coll.) (Janjukian) Lower Miocene.

**Maoritomella balcombensis** n. sp. Pl. 4, fig. 12.

Shell slender, sculptured with rounded spiral cords and dense, flexuous interstitial axial growth striae. Whorls lightly convex, very slightly angled by a peripheral carina, situated about or just below the middle. Above the carina there are two closely-spaced narrow cords submargining the suture, and two distant threads on the shoulder. Below the carina there are two cords equal in strength to the peripheral carina. About 16 primary spirals over body-whorl from the carina to the anterior end. Body-whorl rapidly contracted over base, leaving a long, slender, slightly twisted neck and anterior canal.

Height, 11.9 mm.; diameter, 4 mm.

Height, 9.75 mm.; diameter, 3.5 mm. (holotype).

*Localities:* Balcombe Bay (type); Altona Bay shaft, Victoria (Finlay coll.) (Balcombian) Middle Miocene.

A single half-grown specimen from Gellibrand River has the same arrangement of the spirals, but they are heavier, with narrower interspaces. This may prove to be distinct.

**Maoritomella nutans** n. sp. Pl. 2, fig. 15.

Shell tall and narrow, with slightly pagodiform spire. Outlines almost straight except for the inconspicuous peripheral carina at one fourth whorl height. Above the carina there are four fine threads grouped in pairs, two submargining suture and two on shoulder or sinus area. Below the carina there is a second spiral cord of the same strength as the carina, and a third just emerges from the suture on the body-whorl. About 26 spirals on body-whorl from suture to anterior end.

Height, 12.2 mm.; diameter, 4.5 mm.

*Locality:* Abattoirs Bore, 400-500 ft., Adelaide, South Australia (Finlay coll.) (Adelaidean) Lower Mid. Pliocene.

## Genus **AUSTROCLAVUS** Powell, 1942.

Type (o.d.): Drillia tenuispiralis Marshall, 1918 (Hutchinsonian) Lower Miocene, New Zealand.

A group of *Drillia*-like species easily distinguished by the freely projecting thin outer lip, deeply sinused on the shoulder and insinuated below by a well marked "Stromboid"-notch. Typically, the protoconch is a smooth "Sinusigera," of 4-5 whorls, and the surface of the shell is

smooth and glossy. The Australian members, which include two Recent species, *Melatoma lygdina* Hedley 1922, and *Clavus aeneus* Hedley, 1922, as well as three of the four Middle Miocene species described below, have a fewer-whorled protoconch, but it is of similar style to that of the genotype.

### Key to Species of Austroclavus.

Shell slender, with moderately long canal.
  Axials strong: on all post-nuclear whorls.
    Whorls with subangulate shoulder .................... *lygdinopsis* n. sp.
  Axials subobsolete: on 5 post-nuclear whorls.
    Whorls with angulate shoulder .......................... *glaber* n. sp.
  Axials subobsolete: on 3-4 post-nuclear whorls.
    Whorls with obsolete shoulder angle ........................ *teres* n. sp.
Shell wider, with short canal.
  Axials subobsolete: on 1st post-nuclear whorl only.
    Whorls with angulate shoulder .................... *brevicaudalis* n. sp.

## **Austroclavus glaber** n. sp. Pl. 2, fig. 1.

Slender, attenuated spired, smooth and polished; whorls weakly angulate above the middle. Protoconch smooth, conical, of $2\frac{1}{2}$ whorls, with a small tip, ending abruptly in a thin "Sinusigera" varix. Post-nuclear sculpture of weak, very oblique, axial folds, 13 per whorl, strongest on the early whorls and obsolete after the fifth whorl. Spiral sculpture restricted to about 24 weak threads on the anterior canal. Outer lip tilted forwards in an arcuate sweep, deeply excavated above by the rounded shoulder sinus and indented below by a pronounced "Stromboid"-notch. There is a strong parietal callus-pad. Canal moderately long, unnotched.

Height, 12.25 mm.; diameter, 4.6 mm.

*Localities:* Balcombe Bay (type); Muddy Creek, lower beds, Victoria (Finlay coll.) (Balcombian) Middle Miocene.

## **Austroclavus teres** n. sp. Pl. 2, fig. 3.

Constantly smaller and more narrowly tapered than *glaber*, with obsolete shoulder angle, the axials restricted to the first three or four post-nuclear whorls, and a narrower aperture.

Height, 10 mm.; diameter, 3.1 mm.

*Locality:* Muddy Creek, lower beds, Victoria (Finlay coll.) (Balcombian) Middle Miocene.

## **Austroclavus brevicaudalis** n. sp. Pl. 2, fig. 2.

Larger and broader than *glaber*, with well marked shoulder angle throughout. There are obscure axials on the first post-nuclear whorl only, the anterior canal is short and shallowly notched, and there are only four spirals bunched together on the anterior end.

Height, 16 mm.; diameter, 5.8 mm.

*Locality:* Balcombe Bay, Victoria (Finlay coll.) (Balcombian) Middle Miocene.

### ? **Austroclavus lygdinopsis** n. sp. Pl. 2, fig. 4.

Nearer to the Recent *lygdina* than to the three above described species. Shell slender, with attenuated spire, and moderately long anterior canal. Protoconch smooth, bluntly conic, of 2½ whorls, ending abruptly in a thin flexuous varix. Whorls bluntly angled, below the middle on the early whorls, at the middle on the antepenultimate, and above the middle on later whorls. Sculptured with rather strong, oblique, narrowly rounded axials, obsolete on shoulder area and not quite reaching lower suture, 15 per whorl. The only spiral sculpture consists of closely spaced, fine lirations on the neck and anterior end. Outer lip and sinus as in *glaber*. There is a heavy parietal tubercle which renders the sinus subtubular.

Height, 12 mm.; diameter, 3.9 mm.

*Locality:* Muddy Creek, lower beds, Victoria (Finlay coll.) (Balcombian) Middle Miocene.

The species is reminiscent of the Recent *lygdina*, both in shape and in style of sculpture, but the paucispiral, rather bluntly conical protoconch is a considerable deviation from that of the New Zealand genotype. However, the apertural features are so distinctive and constant in the above series that *lygdinopsis*, for want of a better location, may rest here for the present.

### ? **Drillia stiza** Tenison-Woods, 1880.

1880 *Drillia stiza* Ten.-Woods, Proc. Linn. Soc. N.S.W. 4, p. 12, Pl. 2, fig. 11.

*Locality:* Muddy Creek, lower beds (Balcombian).

I have not seen this species, nor can I suggest a satisfactory location for it. The figure is very poor and does not fit the description.

## Subfamily BORSONIINAE.

### Genus **BORSONIA** Bellardi, 1839.

Type (Monotypy): B. PRIMA Bellardi (Helvetian) Miocene, Turin, Italy.

Turriculid-like shells with two pillar plaits (rarely one). *Borsonia* is widespread in the Tertiary, and there are a few Recent deep-water species. In New Zealand the genus occurs from the (Bortonian) Middle Eocene to the (Hutchinsonian) Lower Miocene.

#### Key to Species of Borsonia.

Shell elongate fusiform.
- Whorls lightly convex, not angled.
  - Axials weak; on early whorls only ...................... *protensa* Tate
- Whorls angulate.
  - Axials obsolescent on body-whorl; 8 on penultimate .... *otwayensis* Tate
    (no specimens available for exact comparison, but *polycesta* is described as having more nodulose axials than *otwayensis*) ...................... *polycesta* Tate
  - Axials persistent over body-whorl; 9 on penultimate ........ *tatei* n. sp.

Shell biconic.
- Whorls carinate.
  - Suture strongly submargined.
    - Axials reaching penultimate ........................ *balteata* Tate
  - Suture weakly submargined.
    - Axials on early whorls only .................... *torquayensis* n. sp.

**Borsonia protensa** Tate, 1898.

1898 *Borsonia protensa* Tate, Proc. Roy. Soc. N.S.W. 31, p. 394, Pl. 19, fig. 6.
*Locality:* Cape Otway, Victoria (Janjukian) Lower Miocene.

**Borsonia polycesta** Tate, 1898.

1898 *Borsonia polycesta* Tate, Proc. Roy. Soc. N.S.W. 31, p. 395, Pl. 19, fig. 2.
*Locality:* Cape Otway, Victoria (Janjukian) Lower Miocene.

**Borsonia otwayensis** Tate, 1898.

1896 *Borsonia otwayensis*, Cossmann, Ess. Pal. Comp. 2, p. 98 (fig. of protoconch only. Specific name not here valid).
1898 *Borsonia otwayensis* Tate, Proc. Roy. Soc. N.S.W. 31, p. 394, Pl. 19, fig. 4.
*Locality:* Cape Otway, Victoria (Janjukian) Lower Miocene.

**Borsonia torquayensis** n. sp. Pl. 1, fig. 11.

Shell small, stout, biconic, sharply medially carinated and sculptured with distinct, sharp spiral cords. Only the first two penultimate whorls bear small peripheral tubercles. Shoulder broadly and shallowly concave, smooth except for a few very indistinct spiral threads. Two distinct closely spaced spiral threads submargin the upper suture. Below the carina on the spire-whorls there are strong narrow cords, one on antepenultimate and two to four on the later whorls. Below the carina to the anterior end of the body-whorl there are 24 sharply raised, narrow spiral cords. About the middle of pillar there are two strong plaits. The species approaches *balteata,* from which it is distinguished by the reduced axial sculpture and weaker subsutural margining.

Length, 9.8 mm.; diameter, 4.45 mm.

*Locality:* Torquay, lower beds, Victoria (Finlay coll.) (Janjukian) Lower Miocene.

**Borsonia balteata** Tate, 1898.

1898 *Borsonia balteata* Tate, Proc. Roy. Soc. N.S.W. 31, p. 395, Pl. 19, fig. 10.
*Locality:* Belmont, Victoria (type) ; Torquay, upper beds, Victoria (Finlay coll.) (Janjukian) Lower Miocene.

**Borsonia tatei** n. sp. Pl. 3, fig. 8.

Species elongate-fusiform, differing from *otwayensis* in being more slender and with more numerous, slightly spinose axials, which persist over all post-nuclear whorls. Whorls angled at the middle. Axials strong, pointed at periphery, rapidly fading out on shoulder and considerably diminished at lower suture. Surface crowded with fine spiral threads and moderately strong cords, roughened by a surface texture resultant from dense axial growth lines. Shoulder with from 4-9 fine spiral threads. Five rather strong flat-topped spiral cords from periphery to lower suture. Interspaces slightly greater than width of cords; each interspace on last whorl develops a fine spiral thread. Spirals on base and neck linear-spaced, numerous, and much weaker than those on spire-whorls. Only one pillar plait showing, at about two-thirds height of aperture.

Height, 21.7 mm.; diameter, 6.75 mm.

*Locality:* Spring Creek, upper beds, Victoria (Finlay coll.) (Janjukian) Lower Miocene.

## Genus **CRYPTOBORSONIA** n. gen.

Type: C. PLEUROTOMELLA n. sp. (Balcombian) Middle Miocene, Victoria.

This is a problematic genus reminiscent in some respects of *Cryptoconus, Pleurotomella, Cordieria* and *Rugobela*, a diverse assemblage representative of at least three subfamilies.

The sinus is almost sutural, as in *Pleurotomella,* or similarly as in the Daphnellid genus *Rugobela*, where the subsutural character of the sinus is masked by a forward trend at the suture. The columella and the protoconch both resemble those of *Cryptoconus,* but the latter is larger and less papillate in *Cryptoborsonia.*

By virtue of a twist-like ridge on the pillar, scarcely a plait, the genus seems to have most in common with the *Borsoniinae.*

### **Cryptoborsonia rugobela** n. sp. Pl. 1, fig. 13.

Small, biconic, with a subsutural fold and concave shoulder. Shoulder angle at two-thirds whorl height. Protoconch damaged, but as in next species. Post-nuclear sculpture of numerous sharply raised, narrow spiral cords 5-8 from shoulder angle to lower suture, 24 on body-whorl; widely spaced on base, weaker and more closely spaced towards shoulder. There are 2-3 weak spiral lirations on the shoulder or sinus area. Axials broadly rounded, strong on spire-whorls, obsolescent on body-whorl, 17 per whorl. Sinus occupying the shoulder, rather deep, arcuate, drawn forwards at the suture and produced forwards below in a broad, arcuate sweep. Outer lip thin. Pillar with a slight median bulge.

Height, 8.5 mm.; diameter, 3.9 mm. (holotype).

*Locality:* Torquay, lower beds, Victoria (Finlay coll.) (Janjukian) Lower Miocene.

### **Cryptoborsonia pleurotomella** n. sp. Pl. 1, fig. 12.

Small, biconic, whorls weakly shouldered above middle, aperture half height of shell. Protoconch relatively large, papillate, of two smooth, rounded whorls. Post-nuclear sculpture of wide-spaced, weak, narrow, spiral cords, 4 from shoulder angle to lower suture and 18 on the body-whorl. There are three very weak spiral lirations on the shoulder. Weak axials from the shoulder angle to the lower suture on the first $2\frac{1}{2}$ post-nuclear whorls. Sinus occupying the shoulder, rather deep, arcuate, drawn forwards at the suture and produced forwards below in a broad arcuate sweep. Outer lip thin. Pillar with a median twist-like ridge.

Height, 10 mm.; diameter, 4.5 mm. (holotype).

*Localities:* Balcombe Bay (type); Muddy Creek, lower beds, Victoria (Finlay coll.) (Balcombian) Middle Miocene.

## Genus **MITRITHARA** Hedley, 1922.

Type (o.d.): COLUMBELLA ALBA Petterd. Recent, Tasmania.

Small biconic, Mitraform Turrids, with two pillar plaits. The New Zealand range is (Waitakian) Upper Oligocene to Recent. In Australia there are the (Balcombian) Middle Miocene species described below, and a number of Recent species.

**Key to Species of Mitrithara.**

Spiral cords dominant.
  Outer lip lirate within. Shell small (5-6 mm.) ...... *daphnelloides* (T.-Wds.)
  Outer lip smooth within. Shell large (14 mm.) ........... *megale* Chapple
Axial ribs dominant.
  Outer lip lirate within. Shell small (6 mm.) ............. *fenestrata* n. sp.

## Mitrithara daphnelloides (Tenison-Woods, 1880).

1880 *Mitra daphnelloides* Ten.-Woods, Proc. Linn. Soc. N.S.W. 4, p. 7, Pl. 2, fig. 3.
1898 *Mitromorpha daphnelloides:* Tate, Proc. Roy. Soc. N.S.W. 31, p. 397.

*Localities:* Muddy Creek, lower beds (type); Balcombe Bay, Victoria (Finlay coll.) (Balcombian) Middle Miocene.

## Mitrithara fenestrata n. sp. Pl. 1, fig. 14.

Shell small, very similar to *daphnelloides*, but with a reversal of the sculptural plan, the spirals being subsidiary to strongly developed axials. Biconic, height of aperture half that of shell. Spiral sculpture of sharply raised narrow cords, 4 on spire-whorls and 20 on body-whorl, the last 8 closely spaced on the anterior end, elsewhere with interspaces from 2 to 4 times width of cords. On the spire the first cord submargins the suture, after which there is a broad, free space on the shoulder or sinus area. Axials strong, narrowly rounded, 15 per whorl. Aperture with two distinct plaits and six short lirations within the outer lip.

Height, 6 mm.; diameter, 2.5 mm.

*Locality:* Balcombe Bay, Victoria (Finlay coll.) (Balcombian) Middle Miocene.

## Mitrithara megale Chapple, 1941.

1941 *Mitrithara megale* Chapple, Mem. Nat. Mus., Vict. 12, p. 121, Pl. 14, fig. 2.

*Localities:* Beach Cliffs, 2½ miles west of Gellibrand River, Victoria (Balcombian?) Middle Miocene.

Juvenile examples in the Finlay collection from Grice's Creek probably belong here also.

## Genus SCRINIUM Hedley, 1922.

Type (o.d.): MITROMORPHA BRAZIERI Smith, Recent, New South Wales.

Small ovate to ovate-biconic shells, with low, dome-shaped, smooth, paucispiral protoconch, wide aperture, very shallow subsutural sinus, very short, widely open, canal and twisted columella.

There are four Recent species in Australia (New South Wales and Southern Australia) and two in New Zealand.

In Australia the genus occurs in the (Janjukian and Balcombian) Lower, Middle Miocene and Recent.

New Zealand occurrences of the genus are (Duntroonian and Waitakian) Upper Oligocene, (Awamoan) Middle Miocene, (Urenuian), Upper Miocene, Waitotaran (Lower Pliocene) and Recent.

**Key to Species of Scrinium.**

Whorls not shouldered.
  Axials confined to first two post-nuclear whorls.
    Subsutural margining cord obsolete .......... *hemiothone* (Ten.-Wds.)

Whorls shouldered.
  Axials persistent, but weaker on body-whorl.
    Subsutural margining cord obsolete.
      Shoulder flattened, not prominent.
        Axials 8 per whorl .............................. *haroldi* n. sp.

    Subsutural margining cord moderate ,bearing 2 cords.
      Shoulder broad and shallow.
        Axials 8-10 per whorl ...................... *duplicatum* n. sp.

    Subsutural margining cord strong.
      Shoulder narrowly excavated.
        Axials 10-12 per whorl ......................... *nanum* n. sp.

## **Scrinium haroldi** n. sp. Pl. 1, fig. 10.

Shell small, ovate-fusiform, aperture less than half shell height. Whorls $6\frac{1}{2}$, including smooth, blunt-tipped, rather narrow protoconch of 2 whorls. Axial sculpture of broad, heavy folds, extending from suture to suture, but not over the base, 8 on the penultimate. Spiral sculpture of regular linear-spaced cords, 14 on the penultimate and about 38 on body-whorl and base. Shoulder flattened, not prominent. No subsutural fold.

Height, 9 mm.; diameter, 3.9 mm. (holoytpe).

*Localities:* Torquay, upper beds (type) and Spring Creek, upper beds, Victoria (Janjukian) Lower Miocene.

Named as a small tribute to Dr. Finlay, who made the collection upon which this paper is based.

## **Scrinium duplicatum** n. sp. Pl. 1, fig. 8.

Resembles above species, but slightly larger, more robust, with a depressed dome-shaped protoconch, medially angulate whorls, and a moderately strong subsutural fold bearing two linear-spaced spiral cords. Whorls 6, including protoconch. Axials heavy, broadly rounded, not extended over base, 8-10 per whorl (8 on penultimate, in holotype). Spiral sculpture of regular linear-spaced cords, 14 on the penultimate (including two on subsutural fold), and about 38 on body-whorl and base.

Height, 10 mm.; diameter, 4.5 mm. (holotype).

*Locality:* Torquay, upper beds, Victoria (Finlay coll.) (Janjukian) Lower Miocene.

## **Scrinium nanum** n. sp. Pl. 1, fig. 9.

Similar to *duplicatum,* but smaller; spiral sculpture weaker, subsutural fold much heavier, not duplicated, and axials obsolete or subobsolete on last half-whorl. Whorls $5\frac{1}{2}$, including smooth, dome-shaped protoconch of $1\frac{1}{2}$ whorls. There is a deep, narrow excavation below the subsutural fold. Axials strong, broadly rounded, neither crossing shoulder exca-

vation nor extending to the base, 10-12 on penultimate. Spiral sculpture of closely spaced fine threads, about 16 on penultimate and about 36 on body-whorl and base, those on the base being the stronger.

Height, 6.1 mm.; diameter, 3 mm. (holotype).
Height, 6.9 mm.; diameter, 3.25 mm. (paratype).

*Locality:* Torquay, upper beds, Victoria (Janjukian) Lower Miocene.

**Scrinium hemiothone** (Tenison-Woods, 1880).

1880 *Columbella hemiothone* Ten.-Woods, Proc. Linn. Soc. N.S.W. 4, p. 14, Pl. 3, fig. 8.
1896 *Buchozia hemiothone:* Cossmann, Ess. Pal. Comp. 2, p. 92.
1898 *Bela (Buchozia) hemiothone:* Tate, Proc. Roy. Soc. N.S.W. 31, p. 393.
1906 *Buchozia hemiothone:* Cossmann, Ess. Pal. Comp. 7, p. 224.

*Locality:* Muddy Creek, lower beds, Balcombe Bay, Victoria (Finlay coll.) (Balcombian) Middle Miocene.

## Subfamily MANGELIINAE.

### Genus GURALEUS Hedley, 1918.

Type (o.d.): MANGILIA PICTA Adams & Angas, Recent, New South Wales.

Small, ovate to elongate-fusiform shells with a shallow sinus, occupying the shoulder, and a simple unarmed aperture. Typically the protoconch is polygyrate, dome-shaped and smooth (Group A in key), but an Australian Tertiary series (Group B in key) has the tip of the protoconch minute and exserted, and is followed by a half to a third of a whorl of brephic axials. More careful study of the nuclear characters of the large number of Recent Australian species is desirable before the significance of the presence or absence of this brephic stage can be properly evaluated.

Angas' *Mangilia flavescens* (Hedley 1922, Pl. 52, fig. 144), New South Wales, seems to be a Recent member of "Group B," with incised sculpture as in *subnitidus, volutiformis* and *adelaidensis*. Chapple's *Guraleus cuspidatus* from the Balcombian is a *Daphnella*.

#### Key to Species of Guraleus.

A. Protoconch polygyrate, dome-shaped, of 3-4 smooth whorls.
  Shell elongate-fusiform. Whorls angled.
    Axials extending from upper suture over base, 10 per whorl.
      Peripheral angle just above middle .................. *chapplei* n. sp.
  Shell ovate-fusiform. Whorls rounded.
    Axials extending from upper suture over base, 12 per whorl.
      Spirals numerous, thread-like, 4 weak primaries on spire whorls .......................... *ludbrookae* n. sp.

B. Protoconch polygyrate, conic, 3-4 smooth whorls, tip minute, exserted, followed by 1/2-1/3 whorl of brephic axials.
  Shell ovate-fusiform to biconic.
    Spiral lirations fine, narrow and numerous.
      Periphery angulate.
        Spirals 7 on penultimate.
          Axials 11 per whorl ...................... *singletoni* n. sp.

Periphery rounded.
Spirals 10 (periphery to lower suture).
Axials 12 per whorl .................... *janjukiensis* n. sp.
Spirals 5, primary + intermediates.
Axials 14 per whorl ........................ *harrisi* n. sp.
Spiral grooves, cutting surface into broad, flat cords.
Periphery subangulate.
Spiral cords 4 (periphery to lower suture).
Axials 10 per whorl .................. *subnitidus* Ludbrook
Axials 6 per whorl .................. *volutiformis* Chapman
Periphery carinate.
Spiral cords 3 (periphery to lower suture).
Axials 10 per whorl ........................ *adelaidensis* n. sp.

## GROUP A PROTOCONCH.

**Guraleus chapplei** n. sp. Pl. 4, fig. 1.

Elongate-fusiform, like the Recent *tasmanicus* (T.-Woods), but narrower. Whorls bluntly angled just above the middle, sculptured with strong rounded axials, 10 per whorl, extending from upper suture completely over base, crossed by distant narrow primary cords and fine interstitial lirations. Spire-whorls with exceedingly fine and numerous lirae on the shoulder, three primary cords from angle to lower suture, and about ten primaries on the body-whorl, six of them distantly spaced, remainder bunched at the neck. The interspaces each have three secondary lirations crossed by much finer dense axial threads. The anterior end is finely lirate. Sinus, aperture and protoconch all typical of the genus.

Height, 12.5 mm.; diameter, 3.9 mm.

*Locality:* Abattoirs Bore, 400-500 ft., Adelaide, South Australia (Finlay coll.) (Adelaidean) Lower Mid. Pliocene.

**Guraleus ludbrookae** n. sp. Pl. 4, fig. 3.

Ovate-fusiform, with rounded whorls. Sinus area defined only by a weakening of the axials and the presence of primary spirals below the middle of the whorls. Axials narrowly rounded, 12 per whorl, extending from upper suture completely over base. Sinus area with 5-7 fine threads. Four weak primaries on spire-whorls and about 14 on body-whorl. Interspaces with 1-2 threads. Anterior end with linear-spaced lirations. Sinus, aperture and protoconch all typical.

Height, 7.8 mm.; diameter, 3 mm.

*Locality:* Abattoirs Bore, 400-500 ft., Adelaide, South Australia (Finlay coll.) (Adelaidean) Lower Mid. Pliocene.

## GROUP B PROTOCONCH.

**Guraleus janjukiensis** n. sp. Pl. 4, fig. 2.

Ovate-fusiform; whorls strongly convex, not shouldered. Sculptured with heavy rounded axials, 12 per whorl; extending from upper suture completely over base. The sinus area, extending a little more than one third down from the upper suture on the spire-whorls, is delicately

sculptured with about 10 very faint threads crossed by equally fine axial hair threads following the shallow concavity of the sinus. Below the sinus area to the lower suture there are 10 narrow crisp threads, and about 30 on the body-whorl. Protoconch polygyrate, conic, of $3\frac{1}{2}$ smooth whorls with minute exserted tip, followed by a half whorl of fine arcuate brephic axials.

Height, 5.75 mm.; diameter, 2.7 mm.

*Locality:* Torquay, upper beds, Victoria (Finlay coll.) (Janjukian) Lower Miocene.

### **Guraleus harrisi** n. sp. Pl. 6, fig. 15.

Similar to *janjukiensis,* but whorls not so strongly convex, weakly angled above middle and with stronger sculpture, consisting of primary and secondary spirals. Axials strong, rounded, 14 per whorl, extending from upper suture completely over base. Spiral sculpture consisting of 8 fine lirations on the shoulder or sinus area, 5 primary spirals with a thread in each interspace from shoulder angle to lower suture, and about 26 primary spirals on body-whorl, the interstitial threads not continuing below the upper third of the base. Protoconch polygyrate, conic, of 3 smooth whorls, with minute exserted tip, followed by a half whorl of straight vertical brephic axial threads.

Height, 7.75 mm.; diameter, 3 mm.

*Locality:* Muddy Creek, lower beds, Victoria (Finlay coll.) (Balcombian) Middle Miocene.

### **Guraleus singletoni** n. sp. Pl. 6, fig. 14.

Fusiform, with tall turreted spire. Whorls sharply angled at about two-thirds whorl height. Axials narrow, 11 per whorl, weak over shoulder, vertical on spire-whorls but arcuate and irregular over body-whorl; extending from upper suture completely over base. Spiral scupture consisting of 4 or 5 weak threads on the shoulder and 7 weak, slightly irregular cords from the shoulder angle to lower suture. On the body-whorl the spiral cords are numerous, linear-spaced but weak, the most distinct being 12 on the anterior end. Protoconch polygyrate, conic, of 3 smooth whorls, followed by a half whorl of fine brephic axials.

Height, 6.5 mm.; diameter, 2.5 mm.

*Locality:* Forsyth's Grange Burn, Victoria (Finlay coll.) (Kalimnan) Lower Pliocene.

### **Guraleus volutiformis** Chapman & Crespin, 1928.

1928 *Guraleus volutiformis* Chapman & Crespin, Rec. Geol. Surv. Vict. 5, Pt. 1, p. 123, Pl. 9, fig. 62.

*Localities:* Sorrento Bore, 1050 ft. (type); Muddy Creek, lower beds, Victoria (Chapman) (Balcombian) Middle Miocene.

### **Guraleus subnitidus** Ludbrook, 1941.

1941 *Guraleus subnitidus* Ludbrook, Trans. Roy. Soc. S. Aust. 65, 1, p. 99, Pl. 5, fig. 22.

*Locality:* Abattoirs Bore, 400-500 ft., Adelaide, South Australia (Finlay coll.) (Adelaidean) Lower Mid. Pliocene.

**Guraleus adelaidensis** n. sp. Pl. 6, fig. 13.

Related to *subnitidus,* having same style of incised spirals, but the shell is smaller, more solid, with a carinate periphery and only three cords on the spire-whorls, and about 19 on the base. There are 5 distinct lirations on the shoulder or sinus area. The uppermost of the three cords on the spire-whorls forms the sharp median peripheral carina. Protoconch polygyrate, conic, of $3\frac{1}{2}$ smooth whorls with minute exserted tip, followed by a half whorl of rather strong vertical brephic axials.

Height, 4.8 mm.; diameter, 2.1 mm.

*Locality:* Abattoirs Bore, 400-500 ft., Adelaide, South Australia (Finlay coll.) (Adelaidean) Lower Mid. Pliocene.

**Guraleus tasmanicus** (Tenison-Woods, 1876).

**Guraleus australis** (Adams & Angas, 1864).

Dennant and Kitson (1903, p. 142) recorded both these Recent species (as *Mangilia jacksonensis* Angas and *Bela australis* Adams & Angas) from Limestone Creek, Glenelg River (Werrikooian) Upper Pliocene, but I have not seen fossil material.

## Subgenus **PARAGURALEUS**, n. subgen.

Type: P. BALCOMBENSIS n. sp. (Balcombian) Middle Miocene.

This is a compact group of Lower Miocene to Recent Australian Turrids, identical with *Guraleus* in adult facies, but with a very different protoconch, which is paucispiral of two globose whorls, assymmetrically wound, with a small tip and terminated by several closely spaced, thin, sinuous brephic axials.

The essential characters of the group, paucispiral protoconch combined with *Guraleus* shape, approximate to those of a New Zealand Upper Miocene to Recent genus, *Antiguraleus* Powell 1942. Nevertheless, it is very doubtful if there is real relationship. It is much more likely that both groups arose by mutation in their respective countries—*Antiguraleus* from *Neoguraleus* and *Paraguraleus* from *Guraleus.*

*Paraguraleus* has a more definite sinus than *Antiguraleus,* the anterior end is not marked off in sculpture and the protoconch is more distinctly of two globose whorls. That of *Antiguraleus* is asymmetric, the tip adpressed, not well marked, but thence suddenly and rapidly becoming inflated, bulging more on one side. The Recent *Guraleus costatus* Hedley, 1922, 80 fathoms, New South Wales, is probably a *Paraguraleus.* This species was included in *Marita* Hedley, 1922, but the type of that genus, *Cythara compta* Adams and Angas, 1864, New South Wales to Western Australia, is not congeneric with any of the foregoing species. It is ovate, short-spired and of Cytharid *(Eucithara)* shape and sculpture, but without the apertural processes. The protoconch in *compta* is minute, smooth, polygyrate conic, of three whorls.

**Key to Species of Paraguraleus.**

Shell elongate-fusiform.
  Spirals; incised grooves cutting surface into flat cords.
    Axials 13 per whorl .................................. *incisus* n. sp.
Shell ovate-fusiform.
  Spirals; regular closely spaced fine threads.
    Axials 12 per whorl .................................. *finlayi* n. sp.
    Axials 12-14 per whorl ............................. *abbreviatus* n. sp.
  Spirals; narrow primary cords with intermediate threads.
    Axials 16 per whorl ............................. *balcombensis* n. sp.

## **Guraleus (Paraguraleus) finlayi** n. sp., Pl. 5, fig. 12.

Ovate-fusiform. Whorls convex, bluntly angled at two-thirds whorl height. Sculptured with heavy rounded axials, 12 per whorl, extending from upper suture over base to neck. These are crossed by fine, closely spaced, spiral threads, much weaker on shoulder, 18 from suture to suture on penultimate and about 48 on the body-whorl. Outer lip thin edged, strengthened behind by an axial. Sinus rounded, distinct, occupying shoulder.

Height, 6.95 mm.; diameter, 3 mm.

*Locality:* Torquay, upper beds, Victoria (Finlay coll.) (Janjukian) Lower Miocene.

## **Guraleus (Paraguraleus) balcombensis** n. sp. Pl. 5, fig. 13.

Ovate-fusiform. Whorls strongly convex, weakly shouldered above the middle. Sculptured with rounded, closely spaced, flexuous axials, 16 per whorl, extending from upper suture over base to the neck; crossed by narrow spiral cords and fine interstitial lirations. Spire-whorls with about 12 lirations on the shoulder, 4 primary cords on the penultimate, and three lirations in each interspace, the middle one of the three slightly stronger. There are about 12 primary cords on the body-whorl and many intermediates. Aperture as in *finlayi.*

Height, 8.5 mm.; diameter, 3.4 mm.

*Locality:* Balcombe Bay, Victoria (Finlay coll.) (Balcombian) Middle Miocene.

There is a Batesfordian ancestor to this species with smaller protoconch and more numerous spirals (R. S. Allan coll.). I have insufficient material to warrant naming it.

## **Guraleus (Paraguraleus) abbreviatus** n. sp. Pl. 5, fig. 11.

Ovate-fusiform. Whorls convex, not shouldered. Sculptured with heavy, rounded axials, 12-14 per whorl, extending from upper suture to lower part of base, crossed by fine, regular, closely spaced spiral threads, 14-15 from suture to suture on the penultimate, and about 40 on the body-whorl. The outer lip is thin edged and slightly incurved, strengthened behind by an axial. Sinus rounded, shallow.

Height, 5.9 mm.; diameter, 2.5 mm. (holotype).

Height, 7.3 mm.; diameter, 3.25 mm.

*Locality:* Abattoirs Bore, 400-500 ft., Adelaide, South Australia (Finlay coll.) (Adelaidean) Lower Mid. Pliocene.

**Guraleus (Paraguraleus) incisus** n. sp. Pl. 5, fig. 14.

Elongate-fusiform. Whorls lightly convex, very slightly shouldered at three-fourths whorl height. Sculptured with strong, rounded, flexuous axials, 13 per whorl, extending from upper suture over base to neck; crossed by incised spiral grooves, 16 from suture to suture on the penultimate and about 42 on the body-whorl. Outer lip thin edged and slightly incurved, strengthened behind by a rounded varix. Sinus rounded, distinct, occupying shoulder.

Height, 9.8 mm.; diameter, 3.5 mm. (holotype).
Height, 15.9 mm.; diameter, 5.2 mm.

*Locality:* Abattoirs Bore, 400-500 ft., Adelaide, South Australia (Finlay coll.) (Adelaidean) Lower Mid. Pliocene.

**?Guraleus (Paraguraleus) obsoletus** (Harris, 1897).

1897 *Mangilia obsoleta* Harris, Cat. Tert. Moll. Brit. Mus., p. 57, Pl. 3, figs 9a-b.

*Locality:* Muddy Creek, Victoria (Balcombian) Middle Miocene.

This species is not included in the key. It is known to me only from the original description and figure, which suggest location in *Paraguraleus.*

## Genus **MAPPINGIA** Ludbrook, 1941.

Type (o.d.): M. ACUTISPIRA Ludbrook, South Australia, Lower Mid-Pliocene.

**Mappingia acutispira** Ludbrook, 1941.

1941 *Mappingia acutispira* Ludbrook, Trans. Roy. Soc. S. Aust. 65, 1, p. 99, Pl. 5, fig. 21.

*Locality:* Abattoirs Bore, 400-500 ft., Adelaide, South Australia (Adelaidean) Lower Mid-Pliocene.

I have not seen this species. From the description it is like a small *Guraleus*, but with a thickened, conspicuously dentate outer lip. The protoconch is polygyrate, of three smooth whorls.

## Genus **ETREMA** Hedley, 1918.

Type (o.d.): MANGILIA (GLYPHOSTOMA) ALICIAE Melvill & Standen, Recent, Loyalty Islands.

Fusiform shells with a small protoconch of 2-3 globular whorls, the last one to two angulate. Adult sculpture of axials and spirals. Aperture with a heavy labial varix, deep rounded to subtubular sinus, occupying the shoulder, and a short anterior canal. There is a heavy parietal tubercle, and usually other denticles and ridges on the pillar, as well as lirations inside the outer lip.

A related New Zealand Miocene genus, *Etremopsis,* has a large polygyrate protoconch of 5-6 carinated whorls, last half-whorl axially costate.

**Key to Species of Etrema.**

Shell narrowly fusiform; turreted; peripheral angle sharp.
Shell small (4-10 mm.).
*Spirals on penultimate 1-2.
Axials 7 per whorl ................ *praespurca* Chapman & Crespin
Spirals on penultimate 2-3.
Axials 10 per whorl ............................ *turrita* Chapple
Spirals on penultimate 3.
Axials 11 per whorl ........... *pseudoelegans* Chapman & Crespin
Spirals on penultimate 3-4.
Interstitial lirations granular.
Axials 13 per whorl ....................... *granolirata* n. sp.
Interstitial lirations absent.
Axials 16 per whorl ....................... *janjukiensis* n. sp.
Shell narrowly fusiform. Shoulder angle weak at 2/3 whorl height.
Spirals on penultimate 4.
Axials 18 per whorl ........................ *morningtonensis* Chapple

Shell broadly fusiform; whorls inflated; shoulder angle distinct.
Shell small (8-14 mm.).
Spirals on penultimate 4.
Axials 10-19 per whorl (covers 4 forms) ...... *bidens* (Ten.-Woods)
Spirals on penultimate 5.
Axials 12 per whorl ............................ *exsculpta* n. sp.
Spirals on penultimate 5-8.
Axials 22-25 per whorl ........................ *obdita* (Harris)
Shell large (17-20 mm.).
Spirals on penultimate 4.
Axials 15 per whorl.
Shoulder gently descending, spirals obsolete
*gippslandensis* n. sp.
Spirals on penultimate 8.
Axials completely absent.
Shoulder concave, sloping inwards, spirally lirate
*mirabilis* n. sp.

*Refers to primary spirals, throughout key.

## Etrema janjukiensis n. sp. Pl. 5, fig. 1.

Similar to *granolirata* in shape and primary sculpture, but without the secondary granular lirations. Also the sinus is deeper and there is a strong parietal tubercle. Protoconch as in *granolirata*. Spire-whorls with 4-5 lirations on the shoulder, 4 narrow spiral cords from peripheral angle to lower suture, the peripheral cord being no stronger than the others. Body-whorl with about 22 spirals, the last 12 linear-spaced on the anterior end. No interstitial threads (excepting 1 below the carina on body-whorl in the holotype only). Axials narrowly rounded, extending from upper suture over the base to the neck, 16 per whorl, weaker on shoulder.

Height, 5.7 mm.; diameter, 2.4 mm.

*Localities:* Table Cape, Tasmania (type); Torquay, upper beds, Victoria (Finlay coll.) (Janjukian) Lower Miocene.

## Etrema granolirata n. sp. Pl. 5, fig. 3.

Small, narrowly fusiform, with medial, sharply angulate periphery. Sculptured with strong, narrowly rounded axials, narrow, sharply raised spirals, the latter undulating over the axials, and dense interstitial granular lirations. Protoconch small, globular, of two smooth whorls, the

second subangulate. Spire-whorls with 7 lirations on the shoulder, 3-4 spiral cords from peripheral angle to lower suture, the peripheral cord being much the strongest. Body-whorl with about 19 primary cords. Granular lirations 2-4 per interspace. Axials strong, undiminished over shoulder and extending half way across base, 13 per whorl. Labial varix heavily rounded. Sinus broad and shallow. Very slight parietal callus pad. No apertural lirations.

Height, 6.2 mm.; diameter, 2.75 mm.

*Locality:* Balcombe Bay, Mornington, Victoria (Finlay coll.) (Balcombian) Middle Miocene.

### **Etrema praespurca** Chapman & Crespin, 1928.

1928 *Etrema praespurca* Chapman & Crespin, Rec. Geol. Surv. Vict. 5, Pt. 1, p. 122, Pl. 9, fig. 60.

*Locality:* Sorrento bore, 1050-1107 feet, Victoria (Balcombian) Middle Miocene.

### **Etrema turrita** Chapple, 1941.

1941 *Etrema turrita* Chapple, Mem. Nat. Mus., Melb. 12, p. 120, Pl. 14, fig. 3.

*Locality:* Altona, Victoria (Finlay coll.) (Balcombian) Middle Miocene.

### **Etrema pseudoelegans** Chapman & Crespin, 1928.

1928 *Etrema pseudoelegans* Chapman & Crespin, Rec. Geol. Surv. Vict. 5, Pt. 1. p. 123, Pl. 9, fig. 61.

*Locality:* Sorrento bore, 1158 feet, Victoria (Balcombian) Middle Miocene.

### **Etrema bidens** (Tenison-Woods, 1879).

1879 *Mangelia bidens,* Ten.-Woods, Proc. Linn. Soc. N.S.W. 3, p. 227, Pl. 20, fig. 2.
1896 *Mangilia bidentata* (sic *bidens* Tate): Cossmann, Ess. Pal. Comp. 2, p. 123.
1897 *Clathurella bidens:* Harris, Cat. Tert. Moll. Brit. Mus., Pt. 1, p. 59.
1898 *Clathurella bidens:* Tate, Proc. Roy. Soc. N.S.W. 31, p. 398.
1922 *Heterocithara bidens:* Hedley, Rec. Aust. Mus. 13, p. 297.

*Locality:* Muddy Creek, lower beds, Victoria (type) (Balcombian) Middle Miocene.

In the Finlay collection there are four closely allied species grouped around *bidens,* but without recourse to the type I am unable at present to evaluate them. No. 1 from Muddy Creek, lower beds, has very convex whorls with obsolete shoulder angle, and axials 16 per whorl, strong from suture to suture. Height 10.5 mm. No. 2, also from Muddy Creek, is broad and squat, with angulate shoulder and 17-19 axials per whorl. Height 8 mm. In size and general features it fits Ten.-Woods description, but not his tall-spired figure. No. 3, from Balcombe Bay, is proportioned like Ten.-Woods' figure, has an angulate shoulder and 10-14 axials per whorl. Height 13.5 mm. The latter form evidently represents Harris' (1897, p. 59) interpretation of *bidens.* No. 4, from Balcombe Bay, is similar in proportions to No. 3, but narrower, more elate, with more numerous spiral cords. The shoulder is more steeply descending, with axials undiminished, and crossed by moderately strong spirals. Axials 13 per whorl. Height 8 mm.

**Etrema exsculpta** n. sp. Pl. 5, fig. 4.

Similar to *bidens*, but with more elate spire and very definite, sharply raised sculpture. Strong, narrowly raised axials extend from upper suture over base to neck, 12 per whorl, crossed by narrow, sharply raised spirals, 5 per whorl below shoulder on spire and about 17 on body-whorl. The shoulder bears 5 narrow but very distinct spiral threads. Sinus deep. Parietal tubercle strong. Outer lip thin-edged, strengthened behind by a heavy varix, and lirate within. Spire almost twice height of aperture.

Height, 8.5 mm.; diameter, 3.8 mm.

*Locality:* Altona Bay, Victoria (Finlay coll.) (Balcombian) Middle Miocene.

**Etrema obdita** (Harris, 1897).

1897 *Clathurella obdita* Harris, Cat. Tert. Moll. Brit. Mus., Pt. 1, p. 59, Pl. 3, figs. 11a-b.
1898 *Clathurella obdita:* Tate, Proc. Roy. Soc. N.S.W. 31, p. 398.
1922 *Heterocithara obdita:* Hedley, Rec. Aust. Mus. 13, p. 297.

*Localities:* Batesford Quarry (R. S. Allan) (Batesfordian); Muddy Creek, lower beds (type); Balcombe Bay, Mornington, Victoria (Finlay coll.) (Balcombian) Middle Miocene.

**Etrema morningtonensis** Chapple, 1934.

1934 *Etrema morningtonensis* Chapple, Mem. Nat. Mus. Melb. 8, p. 164, Pl. 19, figs. 4a, b.

*Locality:* Balcombe Bay, Mornington, Victoria (Balcombian) Middle Miocene.

**Etrema gippslandensis** n. sp. Pl. 5, fig. 2.

Resembles *bidens*, but much larger; differing in the protoconch, having a less angulate second whorl, obsolete shoulder spirals, and absence of granules on the basal spirals. Whorls angled at two-thirds whorl height. Shoulder almost flat, gently descending. Primary spirals 4 on spire-whorls, 15 on body-whorl, with 1-3 weak secondary lirae in interspaces. Axials broadly rounded folds, 15 per whorl, fading out on shoulder and base. Sinus deep. Parietal tubercle strong, a few irregular minute tubercles on lower half of pillar. Inner lip thin at edge, strengthened behind by a heavy varix; very faint lirations within.

Height, 20.5 mm.; diameter, 9.75 mm.

*Locality:* Gippsland Lakes, Victoria (Finlay coll.) (Kalimnan) Lower Pliocene.

**Etrema mirabilis** n. sp. Pl. 5, fig. 5.

Large, differing from all other species of *Etrema* in the total absence of axials, concave, inwardly inclined shoulder and erect, papillate, smooth protoconch of $2\frac{1}{4}$ whorls without a keel. Spiral sculpture of broad, flattened cords separated by narrow, shallow interspaces, 8 on penultimate, 23 on body-whorl. A thread in each interspace over the median area of body-whorl. Sinus deep, subtubular. Parietal tubercle strong. Outer lip thin and crenulated at edge, strengthened behind by a heavy varix, and within by a narrow ridge.

Height, 17.5 mm.; diameter, 7.6 mm. (holotype).

*Locality:* Curdie's River, near Peterborough, Victoria (Kalimnan, fide Finlay) Lower Pliocene (Finlay coll.).

The protoconch of *gippslandensis* is similar except that it does show a slight angulation on the last whorl.

**Etrema bicolor (Angas, 1871).**

Dennant and Kitson (1903, p. 142) recorded this Recent species (as *Clathurella bicolor)* from Limestone Creek, Glenelg River (Werrikooian) Upper Pliocene, but I have not seen fossil material.

*(Etrema trophonalis* Chapman and Crespin, 1928) Rec. Geol. Surv. Victoria 5, pt. 1, p. 122, Pl. 9, fig. 59, Sorrento Bore, 990 feet, Victoria (Balcombian) is not a Turrid (see under *Pseudexomilus).* It is a Pyrenid of the same group as *Aesopus semicostatus* Tenison-Woods 1880, and *Mangilia spica* Hedley 1907. The elongate-conic, smooth protoconch of 2½-3 whorls tapered to a fine point is common to all three species. Also the Recent *spica* has a cinnamon-tinted apex, another feature common in the *Pyrenidae.* These shells may be located in *Retizafra.*

## Genus **ETREMOPSIS** Powell, 1942.

Type (o.d.): Drillia imperfecta Suter (Awamoan) Middle Miocene, N.Z.

A group of Miocene species hitherto considered restricted to New Zealand. The genus is similar to *Etrema* in adult facies, except that apart from a parietal tubercle denticles and plications are constantly absent from the pillar. The protoconch is quite distinct from the small paucispiral apex of *Etrema,* being large, polygyrate, of 5 or 6 whorls, the tip minute and globular, but all remaining whorls sharply carinated. The last half-whorl has regular axials, otherwise the protoconch is smooth and glossy.

**Etremopsis opposita** n. sp. Pl. 5, fig. 7.

Small, fusiform, with tall turreted spire. Whorls convex, but with a straight sloping shoulder at two-thirds whorl height, which forms a slight angle above the greatest peripheral convexity. Sculptured with strong, rounded, vertical axials, 11 per whorl, extending from upper suture over base to neck; crossed by primary cords and secondary lirations. On the penultimate there are 5 lirations on the shoulder, 4 primary cords from shoulder angle to the lower suture, second from above at the periphery, and a single intermediate thread in each interspace. There are 16 primary cords on the body-whorl, last 7 closely spaced on the anterior end. Outer-lip strengthened by a heavy varix. Sinus deep, rounded, occupying the shoulder. Parietal tubercle scarcely developed; no other apertural processes.

Height, 6 mm.; diameter, 2.7 mm.

*Localities:* Altona Bay (type) and Balcombe Bay, Victoria (Finlay coll.) (Balcombian) Middle Miocene.

**Etremopsis contigua** n. sp. Pl. 5, fig. 6.

Close to *opposita,* but constantly of much smaller size, differing in having fewer, heavier, more broadly rounded axials, a much sharper peripheral angle, and a well developed parietal tubercle. Details of spiral sculpture as in *opposita.* Protoconch typical, tall, polygyrate, of 4½ whorls, tip minute, lower whorls carinated below the middle, last whorl with strong brephic axials.

Height, 4.1 mm.; diameter, 2 mm.

*Locality:* Abattoirs Bore, 400-500 ft., Adelaide, South Australia (Finlay coll.) (Adelaidean) Lower Mid. Pliocene.

## Genus **FILODRILLIA** Hedley, 1922.

Type (o.d.): DRILLIA TRICARINATA Tenison-Woods, Recent, deep-water, New South Wales.

This genus is closely allied to *Etrema;* probably a benthic derivative of it; the only constant differences are the blunt, smooth, paucispiral protoconch, lack of apertural denticles, and thin shell. The sculpture is mostly predominantly spiral, but reticulation is produced in some by the development of moderately strong axials. The posterior sinus is deep, rounded, subtubular, and the outer lip often terminates in a distinct hollow varix. Hedley, in his generic diagnosis, mentions the absence of axial ribs and varix, but several of the species he ascribed to his genus exhibit these features. He further complicated the issue by including such species as *Drillia dilecta* Hedley, 1903, *Pleurotoma (Drillia) dilectoides* Chapman and Gabriel, 1914, and *Filodrillia steira* Hedley 1922. These belong to the *Clavinae,* the first and third respectively are *Maoritomella,* and the second is a *Tomopleura.* Chapman and Crespin's *Filodrillia steiroides* (1928, p. 121) is a *Microdrillia.*

**Key to Species of Filodrillia.**

Periphery sharply angulate.
  Axials moderately strong; absent from shoulder.
    Slender; walls almost vertical below keel.
      Penultimate with 2-3 spirals below keel ........... *turricula* n. sp.
  Axials strong; crossing shoulder.
    Broader; walls undercut below keel.
      Penultimate with 1-2 spirals below keel .... *peramoena* (Ludbrook)
Periphery angulate to subangulate.
  Axials very weak, especially on shoulder.
    Slender; walls undercut on early whorls, but rounded on body-whorl.
      Penultimate with 3 spirals below keel ........... *ludbrookae* n. sp.

### **Filodrillia turricula** n. sp. Pl. 5, fig. 8.

Shell slender, with sharply angled periphery, situated above middle; outline of whorls lightly concave on shoulder, straight and almost vertical below. Whorls $6\frac{1}{2}$, including papillate smooth protoconch of $1\frac{3}{4}$ whorls ending in a few brephic axials. Peripheral spiral narrow; three slightly narrower sharply raised spirals below it, lowest at lower suture, and a further 12 spirals on base and neck; those on neck closely spaced; those on base with interspaces 1 to $1\frac{1}{2}$ times width of spirals. Axials slender, slightly oblique, stopped at peripheral keel and extending weakly over the base, 15 on penultimate. The shoulder bears four very delicate spiral threads. Posterior sinus deep, rounded, subtubular. Outer lip arcuately projecting as a hollow varix.

Height, 6.5 mm.; diameter, 2.4 mm.

*Locality:* Balcombe Bay, Mornington, Victoria (Finlay coll.) (Balcombian) Middle Miocene.

### **Filodrillia peramoena** (Ludbrook, 1941).

1941 *Etrema peramoena* Ludbrook, Trans. Roy. Soc. S. Aust. 65 (1) p. 99, Pl. 5, fig. 23.

*Locality:* Abattoirs Bore, 400-500 ft., Adelaide, South Australia (Finlay coll.) (Adelaidean) Lower Mid. Pliocene.

**Filodrillia ludbrookae** n. sp. Pl. 5, fig. 9.

Body-whorl more rounded than in above species; the early whorls only are strongly angulate. Axials much weaker than spirals—numerous spiral threads on shoulder. Whorls $6\frac{1}{2}$, including typical papillate smooth protoconch of $1\frac{3}{4}$ whorls. Peripheral spiral narrow, at middle of whorls; three spirals of equal strength below it, lowest at lower suture; about 16 much weaker spirals on base and neck. Axials very narrow, weak, oblique and flexuous, strongest from peripheral keel to lower suture, but extending weakly both over shoulder and over base to neck. The shoulder bears six fine crisp spiral threads.

Height, 9 mm.; diameter, 3.75 mm. (holotype).

*Locality:* Abattoirs Bore, 400-500 ft., Adelaide, South Australia (Finlay coll.) (Adelaidean) Lower Mid. Pliocene.

## Genus **HETEROCITHARA** Hedley, 1922.

Type (o.d.): Clathurella bilineata Angas, Recent, New South Wales.

Small ovate-fusiform *Mangeliinae* of stout build, axially costate, crossed by spiral cords and dense granular lirations. Outer lip variced, sinus rounded, occupying the shoulder.

The protoconch is polygyrate, broadly conical, with a small smooth tip followed by several whorls of distinct concave axials.

**Heterocithara miocenica** n. sp. Pl. 4, fig. 11.

Short fusiform-biconic; spire turreted; angle just below middle. Sculptured with narrowly-crested axial folds, extending from upper suture to over base, but not on the anterior end, 12 per whorl; crossed by narrow, widely-spaced spiral cords and a dense surface pattern of fine lirations, which are rendered granular by still finer and closer axial threads. There are three primary spirals on the spire-whorls, uppermost at the periphery, lowest half immersed at the lower suture, and eight primary spirals on the body-whorl. Protoconch polygyrate, conic, of $3\frac{1}{2}$ whorls, with small, smooth tip, everted and inrolled; remaining whorls with obliquely curved, sharp axials. Adult apertural features unknown, as both available specimens are immature.

Height, 7.9 mm.; diameter, 3.5 mm.

*Locality:* Balcombe Bay, Victoria (Finlay coll.) (Balcombian) Middle Miocene.

## Genus **ANACITHARA** Hedley, 1922.

Type (o.d.): Mangilia naufraga Hedley, Recent, Queensland.

Shells resembling *Eucithara* in their upper whorls and sculpture, but with a wide, open aperture without denticles. Typically, the protoconch is rather small, smooth, bluntly rounded, of two whorls, followed by a brephic stage of curved axials, but in a series of four Lower and Middle Miocene New Zealand species, and the Tasmanian Lower Miocene species described below, the protoconch is dome-shaped.

**Anacithara janjukiensis** n. sp. Pl. 5, fig. 10.

Ovate-fusiform, with tall spire, robust. Whorls convex, slightly shouldered at two-thirds whorl height. Sculptured with broad, heavy, fold-like axials extending from upper suture over the base to the neck, 10 per whorl; crossed by dense regular lirations, about 25 on the penultimate. Outer lip thin at the edge, but heavily variced behind. Sinus shallow, arcuate, occupying the shoulder. There are no apertural processes.

Height, 8 mm.; diameter, 3.5 mm.

*Locality:* Table Cape, Tasmania (Finlay coll.) (Janjukian) Lower Miocene.

### Genus **EUCITHARA** Fischer, 1883.

Type (monotypy): MANGELIA STROMBOIDES Reeve, Recent, Philippines.

This well known tropical genus is represented abundantly in the Australian Recent Fauna.

**Eucithara glabra** (Harris, 1897).

1897 *Mangilia (Cythara) glabra* Harris, Cat. Tert. Moll. Brit. Mus., p. 58, Pl. 3, figs. 10a-b.
1898 *Mangilia (Cythara) glabra,* Tate, Proc. Roy. Soc. N.S.W. 31, p. 399.

*Locality:* Muddy Creek, upper beds, Victoria (Kalimnan) Lower Pliocene.

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(*Eucithara subglabra* Chapman & Crespin 1928), Rec. Geol. Surv. Victoria 5, pt. 1, p. 121, Pl. 9, fig. 58. Sorrento Bore, 850 feet, Victoria (Balcombian). I have not seen this species, but judging from the original figure and description it belongs to the *Pyrenidae.*

(*Mangelia gracililirata* Tenison-Woods, 1877), Proc. Roy. Soc. Tasm., p. 106. Table Cape, Tasmania (Janjukian) is not a Turrid. I have not seen topotypes, but judging from May's figure of a co-type (1919, Proc. Roy. Soc. Tasmania, for 1918, Pl. 10, fig. 15) and a specimen from Spring Creek, lower beds, the species is a Pyrenid, probably *Retizafra.*

## Subfamily DAPHNELLINAE.

### Genus **DAPHNELLA** Hinds, 1844.

Type (s.d. Herrmannsen 1847): PLEUROTOMA LYMNAEFORMIS Kiener, Recent, Indian Ocean.

This well known, widely distributed Turrid genus has a polygyrate, pointed, elaborately diagonally cancellated, or "engine-turned" sinusigerid protoconch, and a sutural sinus which is moderately deep, more or less vertically descending and then suddenly produced forwards like a reversed letter "L." The shells are elongate-ovate to ovate-fusiform.

**Daphnella cuspidata** (Chapple, 1934).

1934 *Guraleus cuspidatus* Chapple, Mem. Nat. Mus. Melb. 8, p. 164.

*Locality:* Balcombe Bay, Mornington (type); Altona Bay (C. R. Laws coll.) Victoria (Balcombian) Middle Miocene.

A series of topotypes in the Finlay collection shows this species to have a diagonally cancellated sinusigerid protoconch of four whorls, not smooth as described by Chapple. The presence of a strong labial fold causes the sinus to be slightly atypical in being curved forwards at the suture, not vertically descending. In shape, excavated at the neck, this and the following species resemble *Asperdaphne*, but they are nearer to *Daphnella* in essentials.

**Daphnella chapplei** n. sp. Pl. 6, fig. 6.

Differs from *cuspidata* in having twice as many axials and more regular spiral cords. Axials narrowly rounded, oblique, 19 per whorl, but subobsolete over the penultimate and body-whorls. Surface crowded with linear-spaced, narrow, rounded cords, about 19 on penultimate, those on shoulder much finer, and about 50 on the body-whorl. Apertural features as in *cuspidata,* but with a weaker labial fold resulting in a more normal Daphnellid sinus.

Height, 12.2 mm.; diameter, 4.3 mm.

*Locality:* Muddy Creek, lower beds, Victoria (Finlay coll.) (Balcombian) Middle Miocene.

## Genus **ASPERDAPHNE** Hedley, 1922.

Type (o.d.): Daphnella versivestita Hedley, Recent, New South Wales.

Daphnellids with a blunt paucispiral, spirally ridged protoconch instead of a tall, polygyrate, diagonally cancellated "Sinusigera."

The genus occurs Recent in both Australia and New Zealand, but the following are the first Tertiary members to be described.

**Asperdaphne balcombensis** n. sp. Pl. 6, fig. 7.

Fusiform, with convex whorls, excavated base and moderately long, flexed and recurved anterior canal. Sculptured with numerous sharply raised, rounded axials, crossed by crisp primary and secondary spiral cords. Protoconch of $2\frac{1}{2}$ rounded, finely striated whorls, tip small, inrolled; last whorl with a few weak, irregular axials; terminated by a thin sinuous rim. Shoulder slight, at four-fifths whorl height, sculptured with 5-6 fine spiral lirations crossed by arcuate threads which follow the curve of the sinus. The axials run from the shoulder angle over the base to the anterior end, 20 per whorl. On the penultimate these are crossed by 6 crisp, narrow primary cords with a thread in each interspace. On the body-whorl there are about 16 primary cords. The anterior end bears 6 strong cords, but no axials. Outer lip thin, sinus sutural, typical, reversed "L"-shaped, but not deep.

Height, 11 mm.; diameter, 4.25 mm.

*Locality:* Balcombe Bay, Victoria (Finlay coll.) (Balcombian) Middle Miocene.

**Asperdaphne contigua** n. sp. Pl. 6, fig. 8.

Broader, more squat-spired than *balcombensis,* with similar sculpture but fewer axials and spirals. Protoconch similar to that of above species, but more elevated. Axials 12 per whorl, curving half way over concave, smooth shoulder, which is at four-fifths whorl height. Below, the axials extend over the base to the anterior end. There are four narrow but distinct primary spiral cords on the spire-whorls, with a thread in each interspace, and two above the shoulder angle between the uppermost primary and the smooth sinus area. The anterior end bears 9 strong cords, but no axials. Other features as in *balcombensis.*

Height, 6.8 mm.; diameter, 3 mm.

*Locality:* Altona Bay, Victoria (Finlay coll.) (Balcombian) Middle Miocene.

## Subgenus ASPERTILLA n. subgen.

Type: DRILLIA LEGRANDI Beddome, 1883, Recent, Tasmania.

The curious protoconch of the species described below, with its peg-like initial whorl, is found also in *Drillia legrandi* Beddome, Recent, Tasmania (protoconch figured by Hedley, 1900, Proc. Linn. Soc. N.S.W., Pl. 25, figs. 1 and 2). Both species have open clathrate sculpture, as in *Veprecula* and *Nepotilla,* and a deeper sinus than in *Asperdaphne,* although not so deep as in the two above mentioned genera.

**Asperdaphne (Aspertilla) exsculpta** n. sp. Pl. 6, fig. 9.

Shell small, broad, with angulate whorls, deeply excavated at the sutures. Protoconch papillate, of $2\frac{1}{2}$ whorls, tip exserted, peg-like, the whole sculptured with 10 spiral lirations abruptly terminated at the first axial of the post-nuclear sculpture. Axials heavy, rounded, 10 per whorl, crossed by sharply raised spiral cords and interstitial threads. Spire-whorls with three spiral cords, body-whorl with six, each interspace bearing a single thread. Additional to these, there is one thread on the concave shoulder just above the uppermost cord, and eight strong, closely spaced cords on the anterior end. Sinus sutural, moderately deep.

Height, 3.9 mm.; diameter. 2.15 mm.

*Locality:* Abattoirs Bore, 400-500 ft., Adelaide, South Australia (Finlay coll.) (Adelaidean) Lower Mid. Pliocene.

## Genus FENESTRODAPHNE n. gen.

Type: F. PULCHRA n. sp. (Adelaidean) South Australia, Lower Mid-Pliocene.

The above new genus is proposed for a solitary Daphnellid which fits no described genus. It is nearest to *Asperdaphne,* but has a very different protoconch, which is paucispiral, small, rounded, flattened on top, of $1\frac{1}{2}$ whorls, with the tip inrolled. The whole closely axially costate, crossed by two weak spiral keels. The protoconch passes imperceptibly into the post-nuclear sculpture by the addition of spirals, one above and another between the original two. The adult sculpture is of closely spaced, narrow spiral cords and threads, crossed by axial threads. The outer lip is thin, and the sinus sutural, not very deep.

**Fenestrodaphne pulchra** n. sp. Pl. 6, fig. 10.

Small, ovate, with convex whorl outlines, weakly shouldered on the spire-whorls at about four-fifths whorl height by the uppermost and weakest of four narrow primary spiral cords. There is an intermediate thread in each interspace. On the body-whorl there are ten primary cords, and one, sometimes two, threads in the interspaces. The anterior end bears about ten linear-spaced spiral cords. The surface is delicately fenestrated by the crossing of the secondary spirals and closely spaced axial threads.

Height, 6.1 mm.; diameter, 3 mm.

*Locality:* Abattoirs Bore, 400-500 ft., Adelaide, South Australia (Finlay coll) (Adelaidean) Lower Mid. Pliocene.

## Genus **VEPRECULA** Melvill, 1917.

Type (o.d.): CLATHURELLA SYKESII Melvill & Standen, Recent, Gulf of Oman, 156 fath.

The species described below is not a typical *Veprecula,* but it may rest here until others resembling it are found. It has a tall, polygyrate, narrowly-conic, sinusigerid protoconch, but this is sculptured with delicate diagonal cancellations as in *Daphnella,* not diagonally lamellate as in typical *Veprecula.* Also, the sinus is shallower than in *Veprecula* and the shell is broader, more stumpy, with shorter spire and canal. Except for the polygyrate sinusigera the species could be placed just as readily in *Asperdaphne.*

**?Veprecula adelaidensis** n. sp. Pl. 6, fig. 11.

Shell small, broadly fusiform, sculptured with heavy rounded axials crossed by a few strong cords. Surface cancellated by subsidiary spiral and axial threads. There are four primary spirals on the spire-whorls. The third one down is much the strongest and forms the peripheral carina at one third whorl height. About 21 primary spirals on body-whorl, 11 of them linear-spaced on the neck; four subsidiary threads on the shoulder and one or two in the interspaces of the primaries. Axials very heavy, rounded, strongly projecting, vertical, 8 per whorl. The sinus is shaped as in *Veprecula,* although not so deep, but it is deeper than in *Asperdaphne.*

Height, 6.7 mm.; diameter, 3.5 mm. (holotype).

*Locality:* Abattoirs Bore, 400-500 ft., Adelaide, South Australia (Finlay coll.) (Adelaidean) Lower Mid. Pliocene.

## Genus **PSEUDEXOMILUS** n. gen.

Type: P. CAELATUS n. sp. (Adelaidean) Lower Mid-Pliocene, South Australia.

The genus *Exomilus* was provided for a group of small subcylindrical Turrids with a concave base, latticed sculpture, shallow subsutural sinus and a somewhat quadrangular aperture. Of the species ascribed to the genus by its author (Hedley 1922, pp. 333-335) *Mangilia cancellata* Beddome, 1882, seems to be the only one with apical characters resembling those of the genotype. That is with a small, oblique, inrolled

first whorl and the second whorl larger and overhanging the third. The top of the protoconch in the genotype is flat to concave, with a few weak crenulations on the carinate edge. The species *Drillia pentagonalis* and *telescopialis*, both of Verco 1896, have a different style of protoconch, and further divergences in Hedley's assemblage are shown by *Terebra dyscritos* Verco, 1906, and *Mangilia anxia* Hedley, 1909, respectively. The species *Mangilia spica* Hedley, 1907, along with *Etrema trophonalis* Chapman and Crespin, 1928, are not Turrids, but Pyrenids of the same group as *Aesopus semicostatus* Tenison-Woods, 1880. These may be located in *Retizafra.*

The species described below seems to have some affinity with the several groups at present covered by *Exomilus,* but its apical characters are so different that it would be unwise to burden an already overtaxed genus by the inclusion of a further divergent member.

The new genus *Pseudexomilus* is provided for the Abattoirs species. It has a 2½-whorled blunt protoconch, tip smooth, remaining two whorls radially costate. The shell is tall-spired, *Terebra-like,* sculptured with wavy spiral cords crossed by obsolescent axials. The sinus is Daphnellid, descending obliquely and recurrently from the suture, more or less straight, but narrowly rounded at the apex before descending obliquely forward below the weakly defined shoulder.

**Pseudexomilus caelatus** n. sp. Pl. 6, fig. 12.

Protoconch of 2½ whorls, tip bluntly rounded, smooth, following whorls much larger, strongly convex, radially ribbed, 13 radials per whorl. Post-nuclear whorls with strong, flat-topped, sharply raised wavy cords, four on first whorl, six on fourth whorl, nine on penultimate and twenty-two on body-whorl, nine of which are on the anterior end. Axials obsolescent, irregularly but weakly developed throughout, about ten per whorl. Aperture (better shown in paratype) quadrangular. Outer lip not thickened, but lirate within. Anterior canal short, subtubular, not sinused. Anal sinus as described above.

Height, 11.6 mm.; diameter, 3.9 mm. (holotype).

*Locality:* Abattoirs Bore, 400-500 ft., Adelaide, South Australia (Finlay coll.) (Adelaidean) Lower Mid. Pliocene.

## Genus **RUGOBELA** Finlay, 1924.

Type (o.d.): PTYCHATRACTUS TENUILIRATUS Suter (Awamoan) Middle Miocene, N.Z.

In my "New Zealand Recent and Fossil Mollusca of the Family Turridae" I gave reasons for the inclusion of this genus in the subfamily *Daphnellinae.* The genus lacks both the characteristic diagonally cancellated protoconch and the reversed "L"-shaped sinus, but the presence of weak plications near the base of the pillar accords with the typical genus of the subfamily.

In Australia the genus occurs only in the (Janjukian and Balcombian) Lower and Middle Miocene, but in New Zealand, the probable place of origin of the genus, the range extends from the (Kaiatan) Lower Oligocene to the (Awamoan) Middle Miocene.

### Key to Species of Rugobela.

Subsutural cord strong; shoulder rather deeply concave.
  Peripheral angle above middle.
    Axials 20 per whorl ................................. *exsculpta* n. sp.
    Axials 14-15 per whorl ...................... *columbelloides* (T.-Wds.)

Subsutural cord weak; shoulder broad and shallow.
  Peripheral angle below middle.
    Axials 10-12 per whorl ............................. *conospira* (Tate)

## Rugobela columbelloides (Tenison-Woods, 1877).

1877 *Daphnella columbelloides* Ten.-Woods, Proc. Roy. Soc. Tas. for 1876, p. 105.
1898 *Daphnella columbelloides:* Tate, Proc. Roy. Soc. N.S.W. 31, p. 393.
1919 *Daphnella columbelloides.:* May, Proc. Roy. Soc. Tas. for 1918, p. 72, Pl. 10, fig. 14.
1877 *Thala marginata* Tenison-Woods, Proc. Roy. Soc. Tas. for 1918, p. 72 (cited as syn. of *columbelloides).*

*Locality:* Table Cape, Tasmania (Janjukian) (type) Lower Miocene (Finlay coll.).

## Rugobela exsculpta n. sp. Pl. 6, fig. 5.

Resembles *columbelloides,* but with more numerous axials, which are persistent over the body-whorl (obsolescent over body-whorl in *columbelloides).* The sutural cord is heavy, as in *columbelloides,* but the shoulder is broad, as in *conospira.* Axials strong, rounded, slightly oblique, 20 on body-whorl, extending from shoulder-angle to lower suture, not extending over base. Spiral cords moderately strong, 5 to 6 on spire-whorls. Interspaces increasing to two or three times width of cords over middle area of base. Whorls 7½, including smooth, polished, polygyrate protoconch of 3½ whorls.

Height, 7.2 mm. (incomplete); diameter, 3.6 mm. (holotype).

*Locality:* Torquay, upper beds, Victoria (Finlay coll.) (Janjukian) Lower Miocene.

## Rugobela sp.

*Locality:* Aldinga (Lower), South Australia (Janjukian). One example only, definitely of the genus, but too worn for specific determination .

## Rugobela conospira (Tate, 1898).

1898 *Cordieria conospira* Tate, Proc. Roy. Soc. N.S.W. 31, p. 396, Pl. 19, fig. 12.

*Locality:* Muddy Creek, lower beds; Balcombe Bay, Victoria (Finlay coll.) (Balcombian) Middle Miocene.

*Note:* Tate's River Murray Cliffs, S. Australia, and Gellibrand River, Victoria, records probably refer to *columbelloides* Ten.-Woods.

# Genus TELEOCHILUS Harris, 1897.

Type (o.d.): Daphnella gracillima Tenison-Woods. Janjukian (Lower Miocene) Tasmania.

So far as is known, *Teleochilus* is exclusively South Eastern Australian. It occurs in both the Janjukian and Balcombian, and has living near relatives in *Teleochilus royanus* Iredale, 1924, and *Benthofascis* Iredale, 1936. The latter covers two benthic New South Wales species, *Bathytoma biconica* Hedley, 1903, and *B. sarcinula* Hedley, 1905.

*Teleochilus* is a slender, cylindrical Daphnellid with a long aperture and a large blunt protoconch of 1½ depressed spirally lirate whorls. The

sinus is no more than a minute sutural indentation, but the lower inner face of the pillar bears distinct Daphnellid plications. The post-nuclear sculpture is of prominent spirals, the early whorls sometimes crossed by weak axials. The presence of pillar plications in *Teleochilus* as well as the moderately-deep sutural sinus in the assumed Recent ally *Benthofascis* indicates these genera as members of the subfamily *Daphnellinae.*

Iredale's *Teleochilus royanus,* by its punctate, not spirally ridged protoconch, and dominance of the axial over the spiral element in the adult sculpture ,is obviously separable from the fossil series. The new generic name *Litachilus* is here proposed for Iredale's species.

**Key to Species of Teleochilus.**

Protoconch bearing 6 distinct spirals.
  Shell slender, subcylindrical. Aperture capacious.
    Spiral interspaces wide.
      Spire-whorls with 5 flat-topped spirals, lower two bifurcated.
        Axial folds broad, distinct .............. *gracillimus* (T.-Wds.)
    Spiral interspaces linear.
      Spire-whorls with 12-14 fine spirals.
        Axials obsolete .......................... *denseliratus* n. sp.
  Shell ovate-biconic.
    Spire-whorls with 5 pairs of flat-topped spirals.
      Axials obsolete .............................. *duplicatus* n. sp.
Protoconch bearing 8-9 spirals.
  Spirals on protoconch distinct.
    Shell slender, subcylindrical. Base of aperture narrowly contracted.
      Spiral interspaces moderately wide.
        Spire-whorls with 8-9 flat-topped spirals.
          Axial folds weak ..................... *balcombensis* n. sp.
  Spirals on protoconch faint: almost smooth.
    Shell ovate-biconic. Aperture small.
      Spire-whorls with 9-10 linear-spaced spirals.
        Axials obsolete .............................. *comptus* n. sp.

**Teleochilus gracillimus** (Tenison-Woods, 1877).

1877 *Daphnella gracillima* Ten.-Woods, Proc. Roy. Soc. Tas. for 1876, p. 106.

Height, 21 mm.; diameter, 7.4 mm. (topotype).

*Locality:* Table Cape, Tasmania (Janjukian) Lower Miocene.

Tenison-Woods' original species (1877) from Table Cape, is a strongly sculptured shell, very distinct from the Muddy Creek shell (described below) which was erroneously merged with *gracillimus* by both Tenison-Woods (1879) and Harris (1897).

True *gracillimus* has few, rather distant, flat-topped, strong spiral cords (5 on spire-whorls), rather strong, broad, axial folds, and a capacious aperture.

**Teleochilus denseliratus** n. sp. Pl. 3, fig. 10.

1879 *Daphnella gracillima:* Ten.-Woods, Proc. Linn. Soc. N.S.W. 3, p. 226, Pl. 20, fig. 10. Muddy Creek (Lr.) not of Ten.-Wds. 1877.

1897 *Teleochilus gracillimum:* Harris Cat. Tert. Moll. Brit. Mus. 1, p. 65, not of Ten.-Wds. 1877.

1896 *Daphnella gracillima:* Cossmann, Ess. Pal. Comp. 2, p. 94, fig. 15 (protoconch).

1899 *Teleochilus gracillimus:* Cossmann, Ess. Pal. Comp. 3, p. 191, Pl. 8, fig. 4. Not of Ten.-Wds. 1877.

1906 *Daphnobela gracillima:* Cossmann, Ess. Pal. Comp. 7, p. 224. Not of Ten.-Wds. 1877.

Shell very large for the genus, slender, subcylindrical. Aperture more than half height of shell. Post-nuclear sculpture of six flat-topped, linear-spaced cords on first whorl, doubled on next by bifurcation of all cords, and increased to 14 on penultimate; body-whorl with about 58 weak, irregularly developed, narrow cords. There is a slight shoulder sulcus below the second cord from the suture, being marked by a wider interspace, equal to the width of two cords. Axial sculpture obsolete.

Height, 29.3 mm.; diameter, 8.9 mm. (holotype).
Height, 22.6 mm.; diameter, 8.0 mm. (paratype).

*Locality:* Muddy Creek, lower beds (type); Grice's Creek, Victoria (Finlay coll.) (Balcombian) Middle Miocene.

This species is readily distinguished from the Table Cape, Tasmanian *gracillimus* by its dense sculpture of far more numerous linear-spaced spiral cords, larger size, and the flat, not rounded, cords on the protoconch. In both *gracillimus* and in this new species there are six cords on the protoconch.

### **Teleochilus duplicatus** n. sp. Pl. 6, fig. 2.

Shell of moderate size, ovate-biconic. Aperture almost two-thirds height of shell. Whorls strongly convex, greatest convexity just above the middle. Protoconch sculptured with six strong, rounded spiral cords. Post-nuclear whorls with five pairs of strong, flat-topped spiral cords, one pair submargining suture and separated from the remaining four by a moderately deep, narrow sulcus. On the body-whorl there are eleven pairs of cords and nine single cords on the anterior end. Each pair of cords is linear-spaced, but the interspaces between the pairs are half the width of a cord or more. There is no axial sculpture.

Height, 14.1 mm.; diameter, 5.1 mm. (holotype).

*Locality:* Grice's Creek, Victoria (Finlay coll.) (Balcombian) Middle Miocene.

### **Teleochilus balcombensis** n. sp. Pl. 6, fig. 1.

Shell of moderate size, slender, subcylindrical, but with the spire-whorls noticeably convex. Aperture about half height of shell. Post-nuclear sculpture of 8-9 flat-topped, moderately strong cords, with interspaces averaging half their width. Two to four cords on the median area of the body-whorl are bifurcated by a linear groove. There are 26 primary cords on the body-whorl. Shoulder sulcus distinct, situated below the first subsutural cord. Axial sculpture of weak, wide-spaced folds on first 2-3 whorls.

Height, 18 mm.; diameter, 6 mm. (holotype).

*Locality:* Balcombe Bay, Mornington, Victoria (Finlay coll.) (Balcombian) Middle Miocene.

This species is close to *gracillimus,* but differs in having more convex spire-whorls, more numerous and less prominent spiral cords, weaker axials, and a more narrowly contracted base. Also the protoconch bears nine spiral cords, as against six in *gracillimus* and *denseliratus.*

**Teleochilus comptus** n. sp. Pl. 6, fig. 3.

Shell small, ovate-biconic. Aperture almost two-thirds height of shell. Post-nuclear sculpture of 9-10 rather broad, flat-topped cords, with linear interspaces. Shoulder sulcus, a slightly wider interspace between cords 2 and 3 from the suture. About 34 cords on the body-whorl, 10 of which are on the neck. Protoconch almost smooth, showing 8-9 very faint spiral threads. Aperture much smaller than in other species. Lower inside portion of pillar with 7-8 oblique characteristic Daphnellid plications.

Height, 12.7 mm.; diameter, 5 mm. (holotype).

*Locality:* Torquay, upper beds, Victoria (Finlay coll.) (Janjukian) Lower Miocene.

## Genus SYNGENOCHILUS n. gen.

Type: S. RADIAPEX n. sp. (Janjukian) Lower Miocene, Victoria.

This genus resembles the Cancellarid *Inglisella,* but is actually a small, heavily sculptured Daphnellid close to *Teleochilus,* but differing from that genus in having an axially ridged protoconch instead of spiral cords.

**Syngenochilus radiapex** n. sp. Pl. 6, fig. 4.

Shell small, robust, ovate, with bluntly rounded apex. The sculpture consists of heavy rounded axials crossed by narrow spiral cords. The outline of the spire-whorls is stepped at the subsutural sulcus, below which it is straight and vertical. Aperture narrow, about half height of shell. Protoconch large, broad, dome-shaped, flattened on top, of two whorls, first smooth, second with 14 strong, regularly spaced axial ribs. Post-nuclear whorls sculptured with 14 strong rounded axials, vertical to slightly recurrently oblique, extending from suture to suture, but rapidly fading out on base. All post-nuclear whorls crossed by crisp, narrow spiral cords, 10 on spire-whorls and 28 on body-whorl. There are four or five characteristic weak Daphnellid plications on the inner side of the pillar.

Height, 7.25 mm.; diameter, 3.25 mm.

*Locality:* Torquay, upper beds, Victoria (Finlay coll.) (Janjukian) Lower Miocene.

PROTOCONCHS OF AUSTRALIAN TERTIARY TURRIDAE.

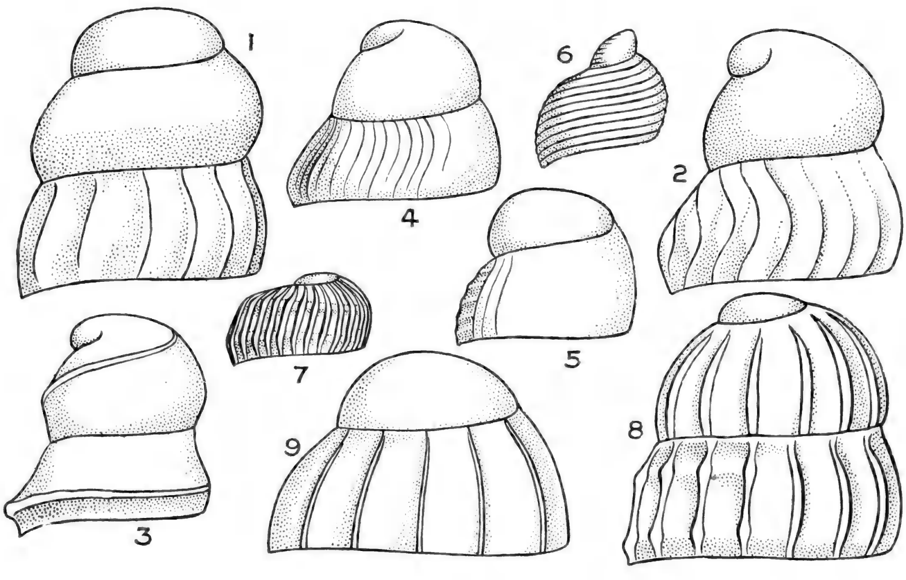


Fig. 1. *Xenuroturris (Veruturris) quadricarinatus* n. subgen. & sp. 2. *Optoturris optatus* (Harris) n. gen. 3. *Coronasyrinx venusta* n. gen. & sp. 4. *Cryptoborsonia pleurotomella* n. gen. & sp. 5. *Guraleus (Paraguraleus) balcombensis* n. subgen. & sp. 6. *Asperdaphne (Aspertilla) exsculpta* n. subgen. & sp. 7. *Fenestrodaphne pulchra* n. gen. & sp. 8. *Pseudexomilus caelatus* n. gen. & sp. 9. *Syngenochilus radiapex* n. gen. & sp. All figures × 30.

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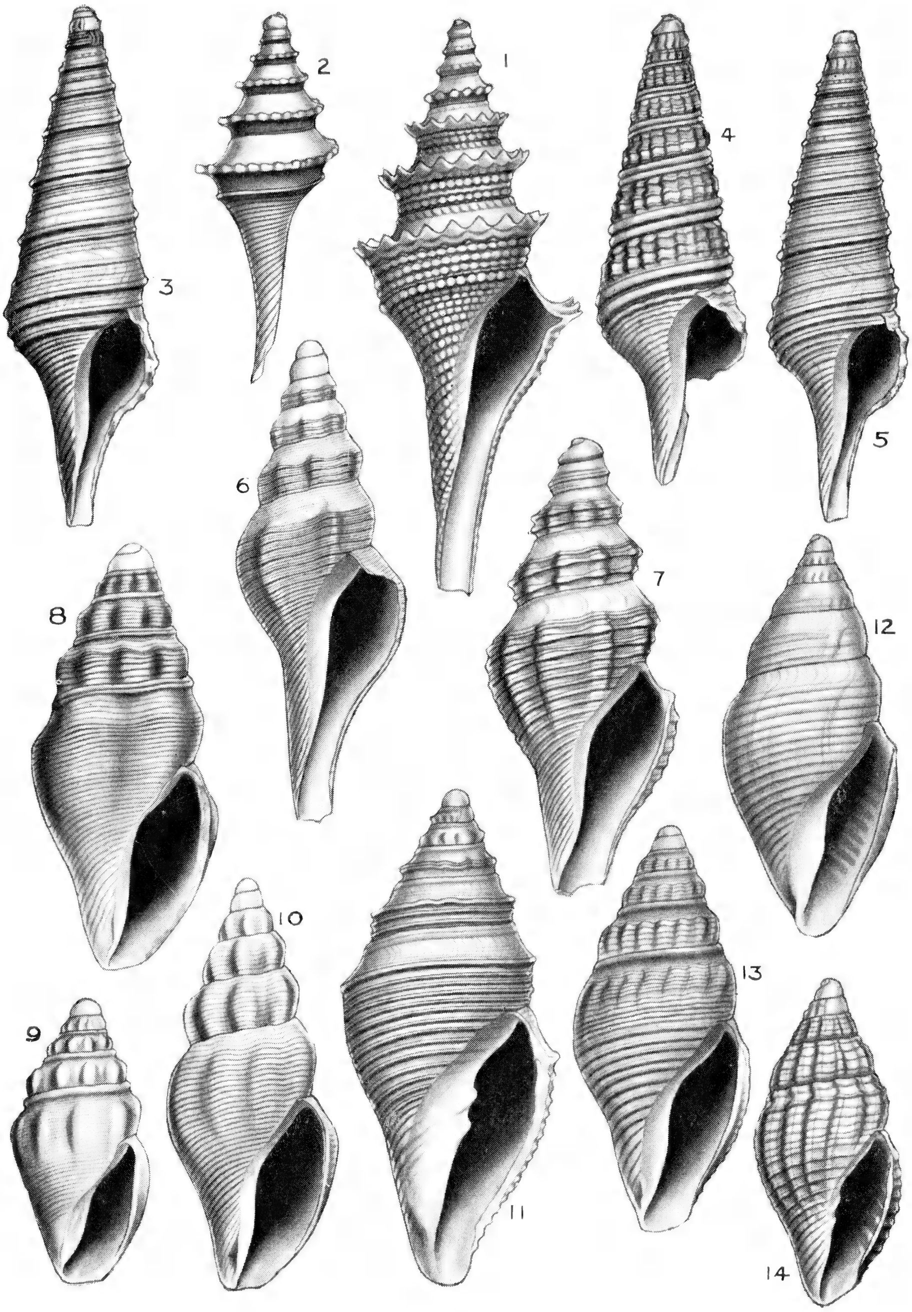
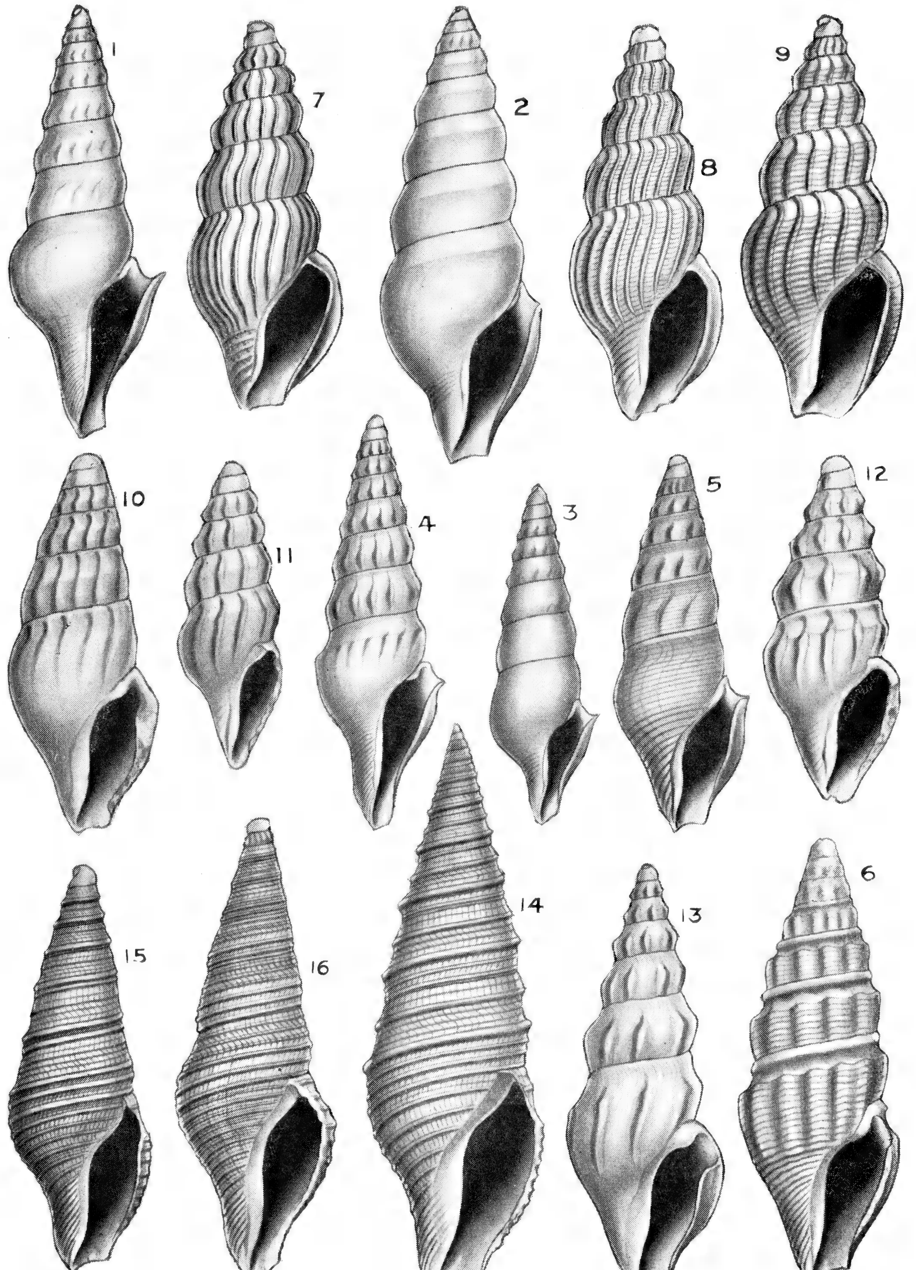
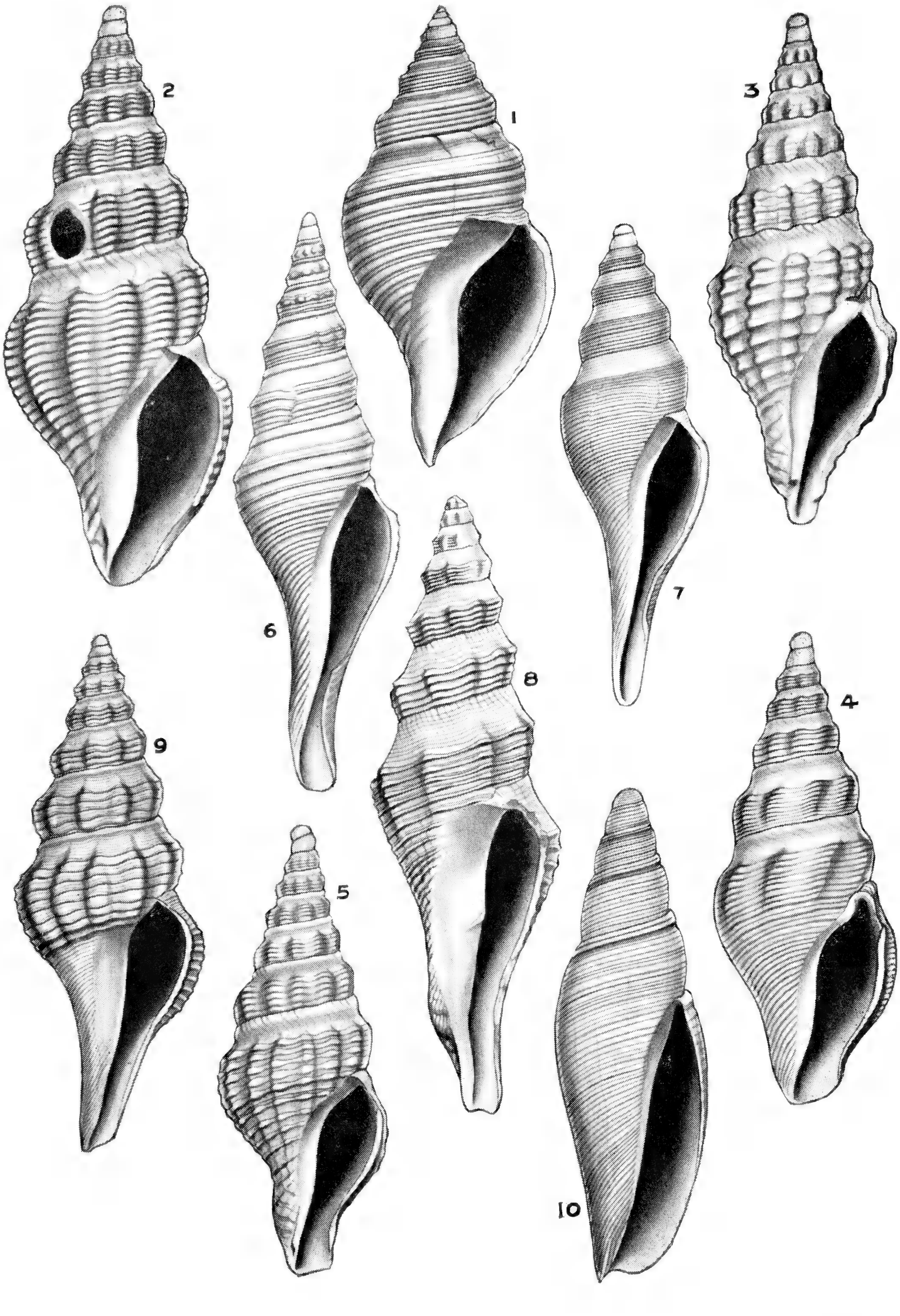


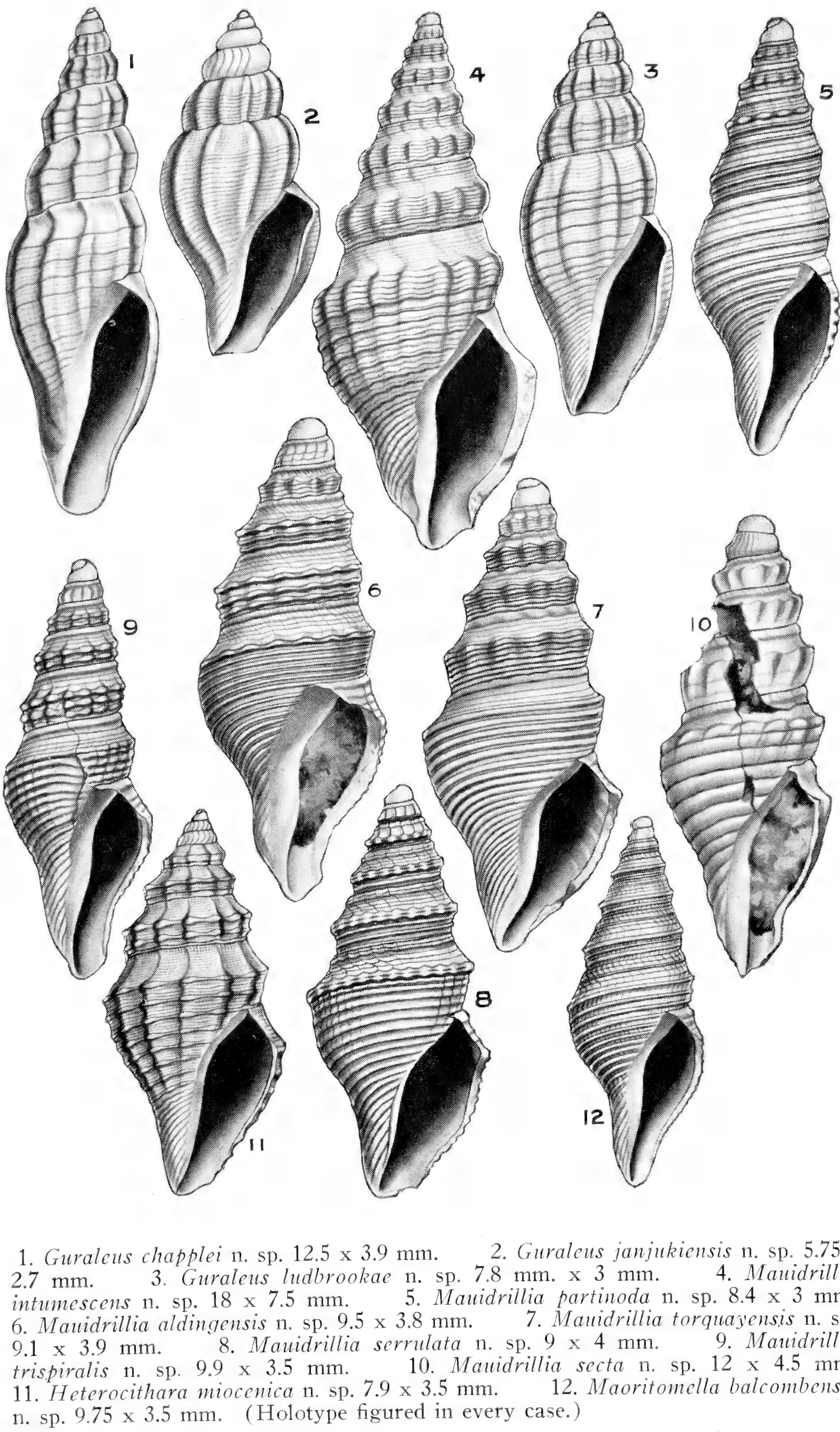

1. *Coronasyrinx venusta* n. gen. & sp. 14.8 x 5.8 mm. 2. *Coronasyrinx semiplana* n. sp. 9.6 x 3.9 mm. 3. *Xenuroturris (Veruturris) tomopleuroides* n. subgen. & sp. 17.5 x 5.5 mm. 4. *X. (Veruturris) bisculptus* n. sp. 13.9 x 4.5 mm. 5. *X. (Veruturris) quadricarinatus* n. sp. 14.5 x 4.2 mm. 6. *Comitas pseudoclarae* n. sp. 14 x 5 mm. 7. *Comitas (Carinacomitas) aldingensis* n. sp. 6.8 x 2.9 mm. 8. *Scrinium duplicatum* n. sp. 10 x 4.5 mm. 9. *Scrinium nanum* n. sp. 6.1 x 3 mm. 10. *Scrinium haroldi* n. sp. 9 x 3.9 mm. 11. *Borsonia torquayensis* n. sp. 9.8 x 4.45 mm. 12. *Cryptoborsonia pleurotomella* n. gen. & sp. 10 x 4.5 mm. 13. *Cryptoborsonia rugobela* n. sp. 8.5 x 3.9 mm. 14. *Mitrithara fenestrata* n. sp. 6 x 2.5 mm. (Holotype figured in every case.)



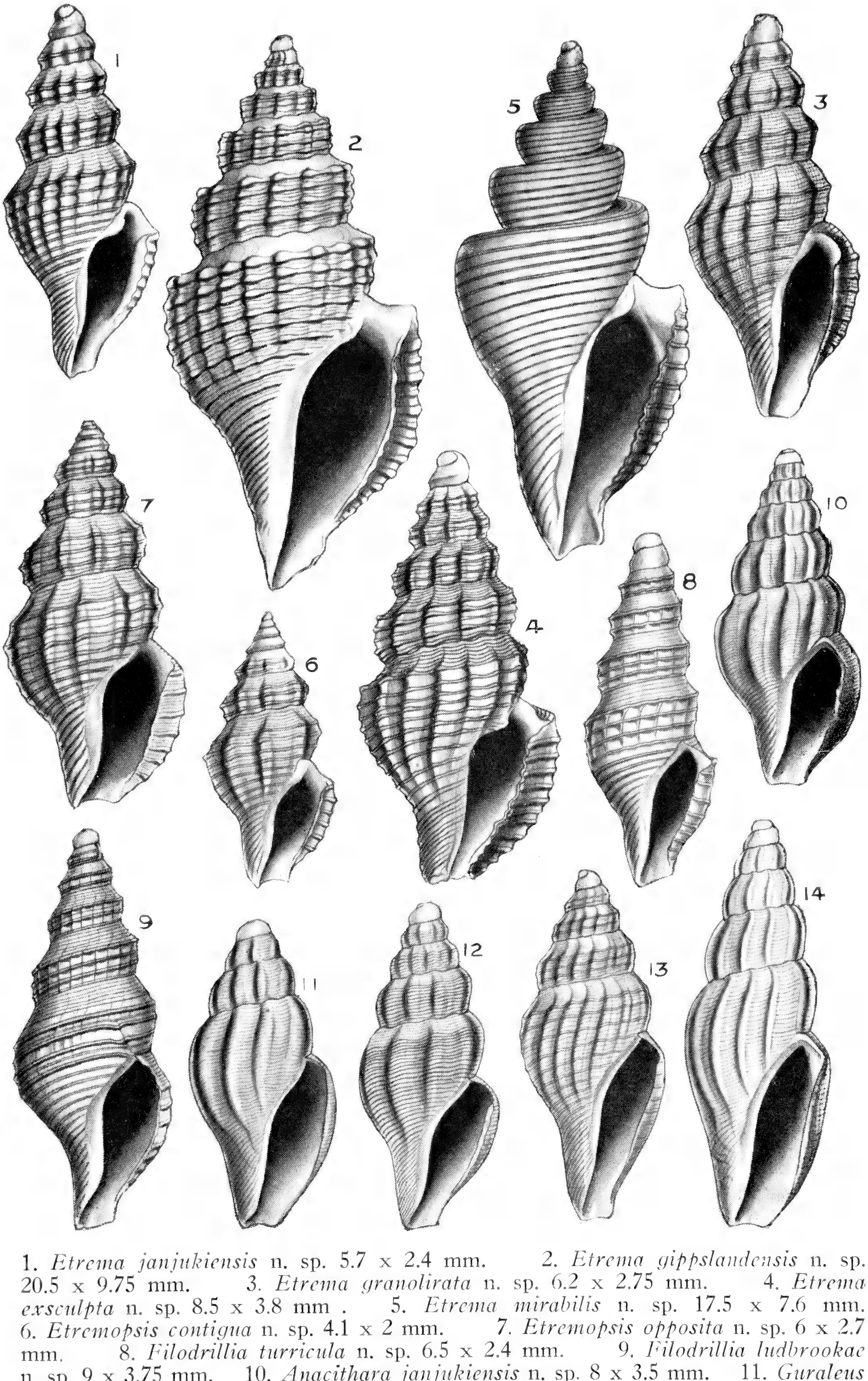

1. *Austroclavus glaber* n. sp. 12.25 x 4.6 mm. 2. *Austroclavus brevicaudalis* n. sp. 16 x 5.8 mm. 3. *Austroclavus teres* n. sp. 10 x 3.1 mm. 4. *Austroclavus lygdinopsis* n. sp. 12 x 3.9 mm. 5. *Splendrillia formosa* n. sp. 10.5 x 3.9 mm. 6. *Splendrillia adelaidae* n. sp. 11.3 x 4.15 mm. 7. *Syntomodrillia venusta* n. sp. 7.9 x 3 mm. 8. *Syntomodrillia complexa* n. sp. 8.9 x 3.6 mm. 9. *Syntomodrillia compta* n. sp. 9 x 3.9 mm. 10. *Syntomodrillia ludbrookae* n. sp. 7 x 2.7 mm. 11. *Syntomodrillia obsoleta* n. sp. 5.3 x 1.9 mm. 12. *Syntomodrillia circinata* n. sp. 6 x 2.5 mm. 13. *Syntomodrillia (Hauturua) exuta* n. sp. 15.6 x 6 mm. 14. *Tomopleura ludbrookae* n. sp. 14.9 x 4.6 mm. 15. *Maoritomella nutans* n. sp. 12.2 x 4.5 mm. 16. *Maoritomella equispiralis* n. sp. 12.5 x 4.2 mm. (Holotype figured in every case.)



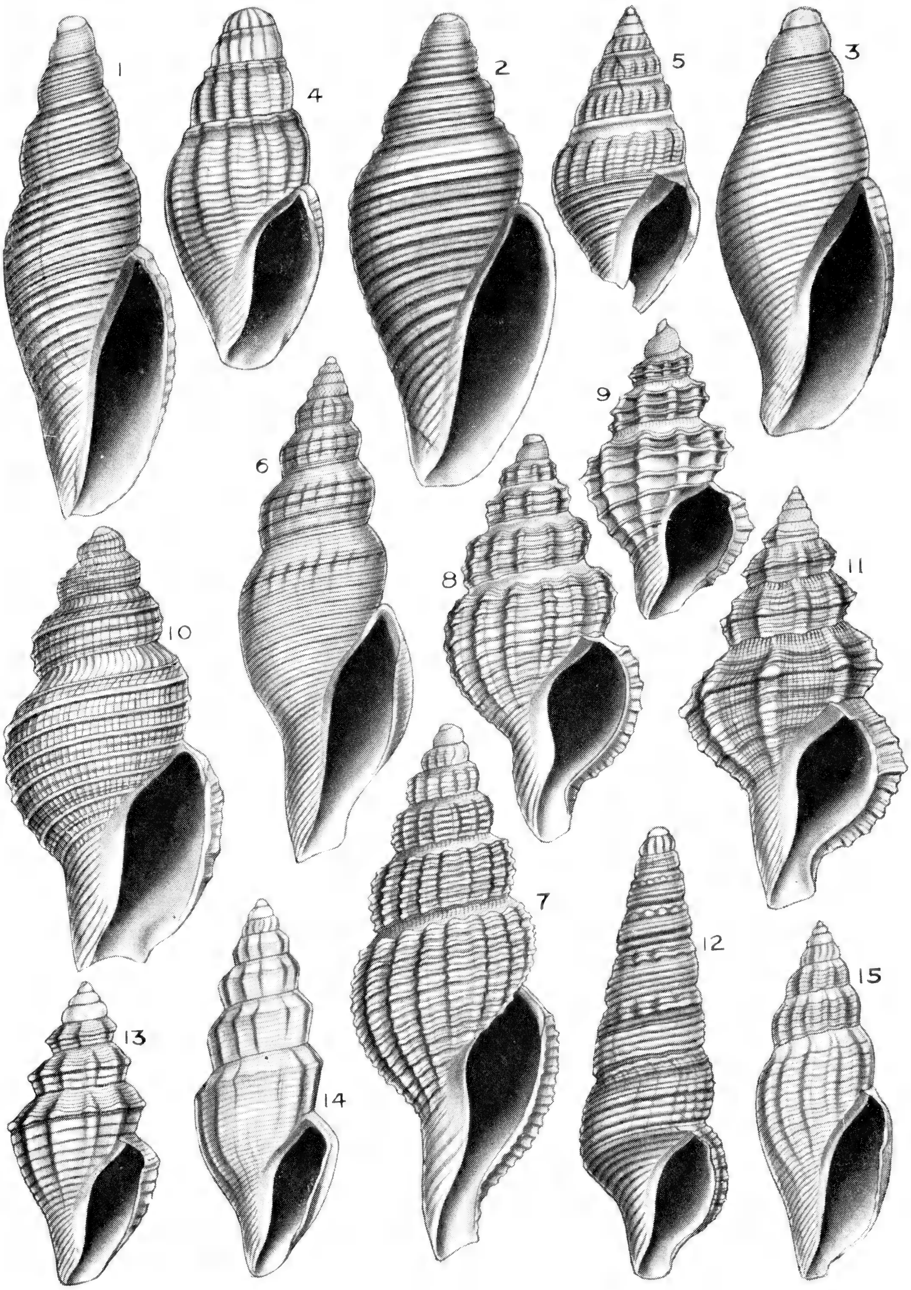

1. *Austrotoma janjukiensis* n. sp. 26.5 x 12.1 mm. 2. *Pseudoinquisitor scabriculus* n. sp. 21 x 7.8 mm. 3. *Pseudoinquisitor trinervis* n. sp. 19.5 x 7 mm. 4. *Pseudoinquisitor delicatulus* n. sp. 17.2 x 6.5 mm. 5. *Pseudoinquisitor gippslandensis* s. sp. 16 x 6.25 mm. 6. *Apiotoma chapplei* n. sp. 18.2 x 5 mm. 7. *Apiotoma pritchardi* n. sp. 20 x 6 mm. 8. *Borsonia tatei* n. sp. 21.7 x 6.75 mm. 9. *Comitas torquayensis* n. sp. 21 x 7.8 mm. 10. *Teleochilus denseliratus* n. sp. 29.3 x 8.9 mm. (Holotype figured in every case.)



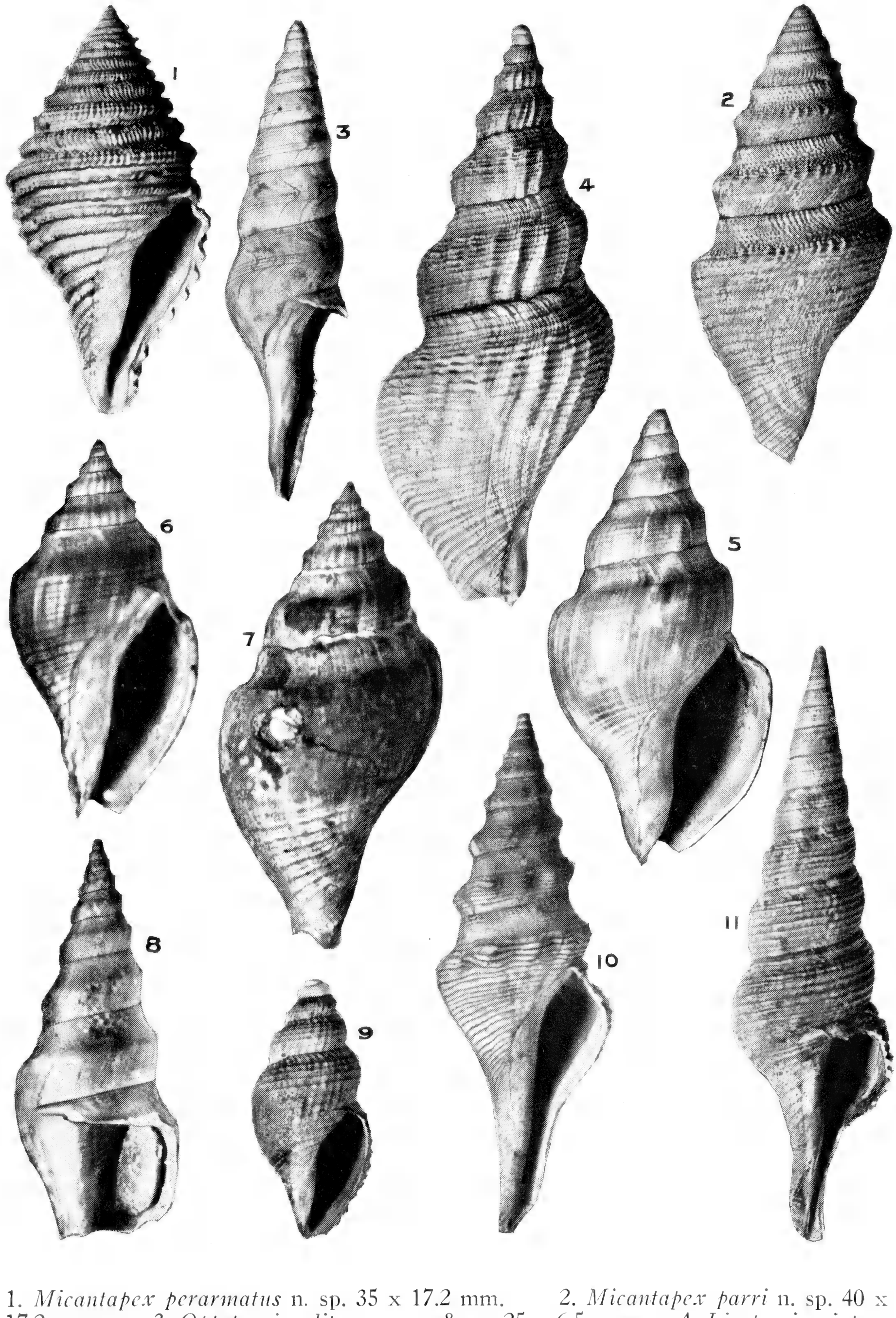

1. *Guraleus chapplei* n. sp. 12.5 x 3.9 mm. 2. *Guraleus janjukiensis* n. sp. 5.75 x 2.7 mm. 3. *Guraleus ludbrookae* n. sp. 7.8 mm. x 3 mm. 4. *Mauidrillia intumescens* n. sp. 18 x 7.5 mm. 5. *Mauidrillia partinoda* n. sp. 8.4 x 3 mm. 6. *Mauidrillia aldingensis* n. sp. 9.5 x 3.8 mm. 7. *Mauidrillia torquayensis* n. sp. 9.1 x 3.9 mm. 8. *Mauidrillia serrulata* n. sp. 9 x 4 mm. 9. *Mauidrillia trispiralis* n. sp. 9.9 x 3.5 mm. 10. *Mauidrillia secta* n. sp. 12 x 4.5 mm. 11. *Heterocithara miocenica* n. sp. 7.9 x 3.5 mm. 12. *Maoritomella balcombensis* n. sp. 9.75 x 3.5 mm. (Holotype figured in every case.)




1. *Etrema janjukiensis* n. sp. 5.7 x 2.4 mm. 2. *Etrema gippslandensis* n. sp. 20.5 x 9.75 mm. 3. *Etrema granolirata* n. sp. 6.2 x 2.75 mm. 4. *Etrema exsculpta* n. sp. 8.5 x 3.8 mm . 5. *Etrema mirabilis* n. sp. 17.5 x 7.6 mm. 6. *Etremopsis contigua* n. sp. 4.1 x 2 mm. 7. *Etremopsis opposita* n. sp. 6 x 2.7 mm. 8. *Filodrillia turricula* n. sp. 6.5 x 2.4 mm. 9. *Filodrillia ludbrookae* n. sp. 9 x 3.75 mm. 10. *Anacithara janjukiensis* n. sp. 8 x 3.5 mm. 11. *Guraleus (Paraguraleus) abbreviatus* n. subgen. & sp. 5.9 x 2.5 mm. 12. *G. (Paraguraleus) finlayi* n. sp. 6.95 x 3 mm. 13. *G. (Paraguraleus) balcombensis* n. sp. 8.5 x 3.4 mm. 14. *G. (Paraguraleus) incisus* n. sp. 9.8 x 3.5 mm. (Holotype figured in every case.)




1. *Teleochilus balcombensis* n. sp. 18 x 6 mm. 2. *Teleochilus duplicatus* n. sp. 14.1 x 5.1 mm. 3. *Teleochilus comptus* n. sp. 12.7 x 5 mm. 4. *Syngenochilus radiapex* n. gen. & sp. 7.25 x 3.25 mm. 5. *Rugobela exsculpta* n. sp. 7.2 x 3.6 mm. 6. *Daphnella chapplei* n. sp. 12.2 x 4.3 mm. 7. *Asperdaphne balcombensis* n. sp. 11 x 4.25 mm. 8. *Asperdaphne contigua* n. sp. 6.8 x 3 mm. 9. *Asperdaphne (Aspertilla) exsculpta* n. subgen. & sp. 3.9 x 2.15 mm. 10. *Fenestrodaphne pulchra* n. gen. & sp. 6.1 x 3 mm. 11. *Veprecula ? adelaidensis* n. sp. 6.7 x 3.5 mm. 12. *Pseudexomilus caelatus* n. gen. & sp. 11.6 x 3.9 mm. 13. *Guraleus adelaidensis* n. sp. 4.8 x 2.1 mm. 14. *Guraleus singletoni* n. sp. 6.5 x 2.5 mm. 15. *Guraleus harrisi* n. sp. 7.75 x 3 mm. (Holotype figured in every case.)




1. *Micantapex perarmatus* n. sp. 35 x 17.2 mm. 2. *Micantapex parri* n. sp. 40 x 17.2 mm. 3. *Optoturris editus* n. gen. & sp. 25 x 6.5 mm. 4. *Liratomina intertexta* n. sp. 44 x 16.5 mm. 5. *Liratomina adelaidensis* n. sp. 32.6 x 16 mm. 6. *Austrotoma inexpectata* n. sp. 22.5 x 11.5 mm. 7. *A. inexpectata*, 28.5 x 13 mm. (paratype). 8. *Zemacies inexpectata* n. sp. 30 x 10 mm. 9. *Belatomina clathrata* n. sp. 17 x 8 mm. 10. *Apiotoma balcombensis* n. sp. 31.3 x 10.6 mm. 11. *Xenuroturris (Veruturris) cochleatus* n. subgen. & sp. 52 x 14 mm. (Holotype figured in every case.)

# Revision of the Araneae of New Zealand

## Part I.

By G. CHAMBERLAIN.

Since the first publication on this interesting but much neglected order, Eleazar Albin's *Natural History of Spiders and Other Curious Insects* (1736), there have been about 50,000 species of Araneae described in several thousand papers. It is thus not surprising that Arachnologists seem to feel that the time has come for the existing knowledge of the order to be brought together for scrutiny and revision. Some 350 species of New Zealand spiders have been described from 1837 to the present day. A survey of these species will show that, in the light of modern knowledge, a large number of them must be regarded as synonyms; the types of nearly half cannot be found, and several of the types in existence are in poor condition. The spiders of New Zealand have not been widely collected and no doubt the list of species will be almost doubled before a satisfactory position is reached. For reasons such as those mentioned and in order to make possible the simple identification of New Zealand spiders, the author has commenced this revision.

### ACKNOWLEDGEMENTS.

I wish to express my gratitude, for invaluable assistance and advice, to Dr. Gilbert Archey, and to my wife.

### HISTORICAL REVIEW.

In 1827 the French corvette "Astrolabe" called at all our outlying islands and remained for some time in Queen Charlotte Sound. The naturalists on board the "Astrolabe," M.M. Quoy and Gaimard, who were ardent collectors, captured several spiders which, in 1837, were named as 10 separate species by Walckenaer in his *Histoire Naturelle des Insectes Apteres.* The types are not known and the descriptions given were not sufficiently detailed to enable future workers to identify their specimens. However, a few species are still associated with the name of Walckenaer. *Araneus crassus* Walckenaer is thus the oldest name applied to a New Zealand spider.

The expedition of H.M.S. "Erebus" and "Terror," under the command of Sir James Ross, in 1841 visited Campbell Island, the Auckland Islands, and the Bay of Islands. Several specimens of spiders were collected from which Adam White in 1849 described eight new species. The types of most of these are preserved in the British Museum, but are in such poor condition as to be unrecognisable.

In 1871 Dr. Ausserer described *Hexathele hochstetteri* from New Zealand. Lucas, Karsch and Hector each described a new species and in 1871 there appeared the first part of *"Die Arachniden Australiens,"* a very comprehensive work on the spiders of Australasia, in which L. Koch added 35 species to the New Zealand fauna. The Rev. O. P. Cambridge, 1879, described 15 species in *Proceedings of the Zoological Society, London,* and in later publications described other species from New Zealand. M. Eugene Simon also contributed a few species to our rapidly increasing list.

Up to this time the arachnologists had been located in Europe, but from 1873 we find that the spiders of New Zealand are the subject of numerous papers in the *Transactions of the New Zealand Institute,* by L. Powell in 1873, P. Goyen 1886, and A. T. Urquhart, who from 1884 to 1893 named and described nearly 200 species.

Later, from 1901 to 1911, H. R. Hogg added 26 species and partially revised some of the earlier established genera. During 1912-1915 the Comte de Dalmas visited New Zealand and his interest was attracted to our spiders. He collected numerous specimens and on his return to France made a study of the Araneae, which resulted in the publication in 1917 of *Araignees de Nouvelle-Zelande.* This revision of the New Zealand spiders reduces the named species considerably, but his reasoning should be accepted with reserve, possibly due to the small amount of material available.

Finally, in 1933-35 Miss Elizabeth B. Bryant examined some of the types of Urquhart's species and redescribed them in modern genera. She also described 11 new species, the results being published in three papers in *Records of Canterbury Museum.* L. Berland, J. B. Gatenby and other workers have also contributed to the knowledge of New Zealand spiders.

## CLASSIFICATION.

Throughout this revision the system of Professor Alexander Petrunkevitch is used (An Inquiry into the Natural Classification of Spiders, *Trans. Conn. Acad. Arts and Science,* 31, pp. 299-389, 1933).

Briefly, the Araneae are Arachnida in which the cephalic and thoracic somites are permanently fused, while the abdomen either remains segmented or more commonly loses its external segmentation during embrylogical development. The abdomen is joined to the cephalothorax by a thin pedicle (first abdominal somite) and bears spinnerets (modified pleiopods) on the fourth and fifth somites.

The orders Kustarachnae, Pedipalpi, Aranae, Palpigradi and Anthracomarti form the Super-Order Caulogastra of the Arachnid Sub-class Epectinata. The order Araneae is divided into five Sub-Orders. The key which follows will serve to distinguish these Sub-Orders.

1. Abdomen segmented in adult .... 1. Sub-Order LIPHISTIOMORPHAE
   Abdomen not segmented in adult .................. 2
2. Abdomen with two pairs book-lungs .................. 3
   Abdomen with one pair book-lungs or none .................. 4

3. Chelicerae paraxial ................ 2. Sub-Order MYGALOMORPHAE
   Chelicerae diaxial ............ 3. Sub-Order HYPOCHILOMORPHAE
4. Abdomen with one pair book-lungs
   4. Sub-Order DIPNEUMONOMORPHAE
   Abdomen with no book-lungs .. 5. Sub-Order APNEUMONOMORPHAE

## 1. Sub-Order Liphistiomorphae.

The Liphistiomorphae include but nine species, of which several are extinct. The surviving species are limited to a relatively small area in Eastern Asia. No specimens of this Sub-Order have been found in New Zealand.

## 2. Sub-Order Mygalomorphae.

Only three of the eight families of Mygalomorphae occur in New Zealand, the Ctenizidae, Dipluridae and the Migidae, the latter being represented by a single genus, and the other families by two genera each.

### Key to Families and Sub-families Occurring in New Zealand, and List of Species.

Branch OCTOSTIATAE.

(Spiders with four pairs of cardiac ostia.)

I. Chelicerae with a rastellum ............................ Fam. Ctenizidae
Sub-Fam. Ctenizinae
*Arbanitis gilliesii* (Cambridge)
*Arbanitis huttoni* Cambridge
*Cantuaria dendyi* Hogg
Chelicerae without a rastellum .................................... II.

II. Lip free. Four or six spinnerets ........................ Fam. Dipluridae
1. Four spinnerets ............................ Sub-Fam. Macrothelinae
*Porrhothele antipodiana* (Walckenaer)
*Porrhothele simoni* Hogg
2. Six spinnerets ............................ Sub-Fam. Hexathelinae
*Hexathele hochstetteri* Ausserer.

Branch SEXOSTIATAE.

(Spiders with three pairs of cardiac ostia.)

Lip immobile. Four spinnerets ............................ Fam. Migidae
Sub-Fam. Miginae
*Migas paradoxus* L. Koch
*Migas distinctus* Cambridge
*Migas sandageri* Goyen

## Branch OCTOSTIATAE.

## Family Ctenizidae.

## Sub-Family Ctenizinae.

### Key to New Zealand Genera.

1. Cervical groove straight or only slightly curved. Sternal sigillae moderate size and marginal.
Genus *Arbanitis* L. Koch
Cervical groove deep and strongly procurved. Posterior sternal sigillae large and removed from margin.
Genus *Cantuaria* Hogg

## Genus **Arbanitis** L. Koch, 1874.

1873 *Pholeuon* L. Koch, Arach. Austr., p. 472 (nom preoc.).
1874 *Arbanitis* L. Koch, loc. cit., p. 491.

Type: A. LONGIPES L. Koch.

Anterior eyes in a very much procurved line (anterior margins of a.m.e. behind posterior margin of a.l.e.)*; eyes equal, medians perhaps a little smaller; posterior eyes much smaller than anterior. I. and II. tibia and metatarsi with thick scopula.

### Key to New Zealand Species.

(After Hogg.)

Cephalothorax of adult not exceeding about 6 mm. in length *A. huttoni* Cambridge
Cephalothorax of adult 8-14 mm. in length .......... *A. gilliesii* (Cambridge)

## **Arbanitis gilliesii** (Cambridge), 1877.

1877 *Nemesia gilliesii* Cambridge, Trans. N.Z. Inst., 10, p. 284, pl. 10.
1892 *Arbanitis gilliesii:* Simon, Hist. Nat. Ar. I., p. 115.
1901 *Arbanitis gilliesii:* Hogg, Proc. Zool. Soc. 1901, p. 233, fig. 24.

Cephalothorax longer than wide, dark brown, ocular area black; cervical groove slightly recurved; anterior row of eyes strongly procurved, a.l.e. twice diameter of a.m.e., posterior row of eyes recurved, p.m.e. smallest of the eyes; ocular quadrangle twice as wide as long, quadrangle of median eyes nearly twice as wide posteriorly as anteriorly; legs (4, 1, 2, 3) with moderate covering of hairs, a number of spines on ventral surface (disposition of spines not constant); three tarsal claws, superior pair irregularly pectinate, inferior claw at ventral edge of tarsus; I. and II. tarsi and metatarsi with scopula; tarsi of pedipalp with claw usually with one long pectination; chelicerae prominent, furnished with longitudinal bands of stout hairs, retromargin with few strong teeth; abdomen elongate oval, four spinnerets, superior pair very much longer than inferior pair.

*Distribution:* Type locality Oamaru. Appears to be confined to the South Island. I have examined only six specimens from Oamaru, Timaru, Christchurch (Hagley Park) and Kaiapoi.

## **Arbanitis huttoni** Cambridge, 1879.

1879 *Arbanitis huttoni* Cambridge, Proc. Zool. Soc. 1879, p. 682, pl. 52, fig. 1.
1891 *Arbanitis huttoni:* Goyen, Trans. N.Z. Inst., 24, p. 255.
1901 *Arbanitis huttoni:* Hogg, Proc. Zool. Soc., 1901, p. 236, fig. 24.

*Distribution:* Type locality Dunedin. I have not seen this species.

The key given by Hogg (see above) for the separation of the two New Zealand species of *Arbanitis* may be used as a guide only. An adult specimen of *A. gilliesii* has been seen in which the cephalothorax is 5 mm. long. However, it appears from the descriptions of the males that the two species are distinct.

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*a.m.e. = anterior median eyes; a.l.e. = anterior lateral eyes; p.m.e. = posterior median eyes; p.l.e. = posterior lateral eyes.

## Genus **CANTUARIA** Hogg, 1902.

1901 *Maoriania* Hogg, Proc. Zool. Soc., 1901, p. 236 (nom preocc.).
1902 *Cantuaria* Hogg, loc. cit., 1902, p. 123.

Type: C. DENDYI Hogg.

Differs from *Arbanitis* in that anterior eyes are only slightly procurved, the posterior margins of the a.l.e. in line with centres of a.m.e. The cervical groove is deep and procurved. The lip is broader than long. The posterior sternal sigillae are large, half way between margin and central line of sternum, and the others are away from margin. I. and II. tarsi with thick scopula.

### **Cantuaria dendyi** Hogg, 1901.

1901 *Maoriania dendyi* Hogg, Proc. Zool. Soc., 1901, p. 236, fig. 25.
1902 *Cantuaria dendyi* Hogg, loc. cit., 1902, p. 123.

Cephalothorax a little longer than wide, anterior truncated; pars cephalica rising abruptly from deep and strongly procurved cervical groove; anterior eyes in a procurved line at equal distance from each other; posterior row slightly recurved; a.l.e. largest, twice diameter of a.m.e.; p.m.e. smallest; quadrangle of median eyes narrower in front than behind and a little wider than high; teeth of rastellum deep black; labium broader than long, concave anteriorly and curved posteriorly with the sternum; maxillae long, straight, with base thickened curved over anterior of lip; legs relatively short; tarsi and metatarsi I. and II. with thick scopula; few stout spines on all legs, but disposition not constant.

The females of this species construct deep burrows (average 5 in. deep) in a sloping bank. The burrow is not normally lined with silk except around the trap-door, which is elliptical, about ½ inch in diameter. Myers (*N.Z. Journ. Sci. Tech.*, 9, p. 129, 1927) notes that some of the females showed fight, while others feigned death, and the male was quite active and very fierce. I have not seen the male of this species, and it has not yet been described.

*Distribution:* Type locality Christchurch. This species has been taken at Timaru, Cave, Lyttelton, Hamner Springs and Picton. Myers (loc. cit.) reports the species from Wellington, where several burrows were shown to him by Professor Kirk.

## Family **Dipluridae.**

## Sub-Family **Macrothelinae.**

## Genus **PORRHOTHELE** Simon, 1892.

1837 *Mygale* Walckenaer, Ins. Apt., I., p. 229.
1871 *Hexops* Ausserer, Verh. Ges. Wien., 1871, p. 155.
1892 *Porrhothele* Simon, Hist. Nat. Ar., I., p. 185.

Type: P. ANTIPODIANA (Walckenaer).

Anterior row of eyes in a straight line or slightly procurved, subequal, p.m.e. smaller than a.m.e., sternum a little longer than wide; lip thickly spined.

**Key to New Zealand Species.**

1. Cervical groove deep and round ........... *P. antipodiana* (Walckenaer)
   Cervical groove long and transversely straight .......... *P. simoni* Hogg

## **Porrhothele antipodiana** (Walckenaer) 1837.

1837 *Mygale antipodiana* Walckenaer, Ins. Apt., 1, p. 230.
1846 *Mygale quoyi* Lucas, in d'Orbigny, Dict. d'Hist. 8, p. 503, pl. 1.
1849 *Cteniza hexops* White, Proc. Zool. Soc., 1849, p. 3.
1849 *Cteniza antipodium* White, loc. cit. supra.
1871 *Hexops whitei* Ausserer, Verh. Ges. Wien. 1871, p. 155.
1873 *Macrothele huttoni* Cambridge, Trans. N.Z. Inst., 6, p. 200, pl. 6, figs. 14 and 19.
1891 *Macrothele insignipes* Simon, Ann. Soc. Ent. Fr., 60, p. 308.
1892 *Porrhothele antipodiana:* Simon, Hist. Nat. Ar., I., p. 185.
1893 *Nemesia kirkii* Urquhart, Trans. N.Z. Inst., 26, p. 204.
1901 *Porrhothele antipodiana:* Hogg, Proc. Zool. Soc., 1901, p. 266.

A useful description of this species is that given by Cambridge for his species *Macrothele huttoni* (loc. cit.). The cephalothorax varies in colour, but is always unusually bright, with a darker area from the eye-space to the cervical groove. The chelicerae are also of a darker and more brownish colour. The a.m.e. are not quite their diameter apart.

This species is one of the original ten described by Baron Walckenaer from the collections of the "Astrolabe." The type is preserved dry and as a result must be very much distorted. Simon *(Ann. Soc. Ent. Fr.,* p. 307, 1891) described the type, which was then 64 years old. Pocock *(Ann. Mag. Nat. Hist.,* Ser. 6, 16, p. 224, 1895) gives an interesting discussion on the synonymy of the species and on the validity of the generic name. A specimen bearing the label *Nemesia kirkii* in the handwriting of A. T. Urquhart has been examined, and this species is now placed in synonymy as shown above.

*Distribution:* Quite common in the South Island, but not so common in the North Island; fairly generally distributed.

## **Porrhothele simoni** Hogg, 1901.

1901 *Porrhothele simoni* Hogg, Proc. Zool. Soc., 1901, p. 271, fig. 38.

Cephalothorax usually a bright red-brown to dark brown; a little longer than broad, pars cephacila moderately raised, eye space more or less flat, sloping gradually to the cervical groove, which is deep and transversely straight or slightly procurved; anterior row of eyes slightly procurved, eyes of equal size, a.m.e. their diameter apart; posterior row of eyes moderately recurved, p.m.e. smallest of the eyes; ocular quadrangle much wider than long, quadrangle of medians wider posteriorly than anteriorly; chelicerae black, furrow with 1 small—5 large—1 small—4 large teeth on inner margin and a median row of small teeth; sternum with thin covering of fine hair; sigillae medium-sized and marginal; lip convex, covered with short club-shaped spines; legs stout, superior tarsal claws pectinate in a single row diagonally; pedipalp of female with claw pectinate in single row; abdomen oval, four spinnerets, superior pair long, 1st and 3rd joints equal and longer than 2nd.

*P. antipodiana* (Walck.) shows a wide variation in colour and structure. This is probably the explanation of its having been described under

so many different names. The present species also shows a variation in colour and to a certain extent in structure, but the character of the cervical groove and the wider separation of the a.m.e. appear to be sufficiently constant to separate the species. It would perhaps be more likely that Hogg's species is a variety of *P. antipodiana* (Walck.), but until a wider series of specimens is available this cannot be confirmed.

*Distribution:* Confined to South Island, and appears to be rare. Type locality is Christchurch. I have captured specimens on the Port Hills, Christchurch.

## Sub-Family **Hexathelinae.**

### Genus **HEXATHELE** Ausserer, 1871.

1871 *Hexathele* Ausserer, Verh. Ges. Wien., 21, p. 171.
1873 *Hexathele:* L. Koch, Arach. Austr., p. 459.

Type: H. HOCHSTETTERI Ausserer.

Pars cephalica slightly elevated, cervical groove transverse. Ocular tuber transverse, convex, short distance from edge of clypeus; anterior eyes slightly procurved; p.m.e. equal or a little smaller than a.m.e.; sternum much longer than wide; lip nearly as long as wide; legs (4, 1, 2, 3) not scopulated.

**Hexathele hochstetteri** Ausserer, 1871.

1871 *Hexathele hochstetteri* Ausserer, Verh. Ges. Wien, 21, p. 172, pl. 1, figs. 4-6.
1873 *Hexathele hochstetteri:* L. Koch, Arach, Austr., 1, p. 459, pl. 35, fig. 7.
1886 *Hexathele petrieii* Goyen, Trans. N.Z. Inst., 19, p. 207.
1901 *Hexathele hochstetteri:* Hogg, Proc. Zool. Soc. 1901, p. 276, fig. 41.
1908 *Hexathele huttoni* Hogg, Proc. Zool. Soc., 1908, p. 337.
1908 *Hexathele websteri* Hogg, loc. cit. supra., fig. 73.

A description of this species suitable for the present purpose is given by Goyen for his *Hexathele petrieii.* The species shows a very wide variation in colour and structure; the cephalothorax grades in colour from bright rose by a series of shades to black and even slate-blue. A similar series of varieties occur in the dorsal abdominal pattern (the normal lighter coloured chevrons may be entirely absent) and in the colouration and outline of the book-lungs on the ventral surface. The relative positions of the eyes also show some slight differences. All the specimens dissected possessed four pairs of cardiac ostia.

The four species were placed in synonymy after a careful examination of nearly 200 specimens (of which half were dissected). The synonymy has been verified by breeding the spider in captivity. It is hoped to publish full details of the morphology and life history of *Hexathele hochstetteri* Auss.; briefly the chief differences in structure given for the four species may be identified with various stages in development from about the fourth ecdysis to the adult spider. Dalmas (*Ann. Soc. Ent. Fr.*, 86, p. 317, 1917) suspected something of this nature, remarking of the four species, "They may not refer to a single species, but I very much doubt if they are all valid."

*Distribution:* Both Islands, quite common. The species appears to be social in habit.

## Branch **OCTOSTIATAE.**

## Family **Migidae.**

## Sub-Family **Miginae.**

## Genus **MIGAS** L. Koch, 1873.

1873 *Migas* L. Koch, Arach. Austr., I., p. 467.

Type: M. PARADOXUS L. Koch.

Ocular area compact, wider than long; anterior eyes in a straight line or but slightly curved, distant width of eyes from edge of clypeus; posterior eyes smaller than anterior.

**Key to New Zealand Species.**

1. Unique double row of stout spines on metatarsus I. and II. .............. 2
   No such row of stout spines on metatarsus I. and II. .... *M. sandageri* Goyen
2. a m.e. their diameter apart ...................... *M. distinctus* Cambridge
   a.m.e. half their diameter apart .................... *M. paradoxus* L. Koch

### **Migas paradoxus** L. Koch, 1873.

1873 *Migas paradoxus* L. Koch, Arach. Austr., 1, p. 467, pl. 36, fig. 1.

Cephalothorax orange-yellow with more or less radiating lines of light-brown (colour varies) ; roughly oval with major axis truncated anteriorly, abdomen overlapping on posterior slope; pars cephalica slightly raised, set with upright bristles, sloping gradually to cervical groove which is half-moon shaped, deep, recurved; ocular quadrangle transverse, about 1½ times broader than long; anterior row of eyes straight, lower margins of eyes in same line, a.m.e. largest of the eyes, separated about half their diameter, same distance from a.l.e.; posterior row of eyes recurved, p.m.e. smallest of the eyes, widely separated; clypeus high, 1½ times diameter a.m.e.; chelicerae dark-brown, sparsely set with bristles; maxillae rounded at base, anterior with hair fringe; lip as long as broad; sternum glossy with fine hairs, elongate oval in form; legs (4. 1, 2, 3) short, stout; I. and II. tibia and metatarsi with double row of curved spines; superior tarsal claws curved, hook-shaped, with two or three teeth, inferior claw without teeth; abdomen brownish, darker band length of dorsal surface widening anteriorly and posteriorly, with dense covering of fine hairs; four spinnerets, inner pair slender, short, outer pair long.

*Distribution:* Type locality Auckland. Both Islands, more common in North Island.

### **Migas distinctus** Cambridge, 1879.

1879 *Migas distinctus* Cambridge, Proc. Zool. Soc., 1879, p. 683, pl. 52, fig. 2.
1886 *Migas distinctus:* Goyen, Trans. N.Z. Inst., 19, 210.
1911 *Migas distinctus:* Gatenby, Trans. N.Z. Inst., 44, p. 234, pl. 15.

Cambridge described the species from a female, Goyen described the male (loc. cit.), the former giving a good figure of the entire specimen and an outline showing the disposition of the eyes. Both papers are

readily available and no useful addition can be made at this stage to the descriptions given. Gatenby (loc. cit.) has given a very interesting account of the life history and habits of this spider.

*Distribution:* Both Islands, not uncommon, but rather difficult to find. The type locality is Dunedin, and Goyen (loc. cit.) notes that he has captured specimens at Portobello and along the coast nearly to Oamaru. My own collection shows the species to be confined to coastal areas in both islands: Timaru, Rangitata, Miramar, Napier, Tauranga, Waiheke Is., etc.

## **Migas sandageri** Goyen, 1890.

1890 *Migas sandageri* Goyen, Trans. N.Z. Inst., 23, p. 123, pl. 20.
1917 *Migas paradoxus* L. Koch: Dalmas, Ann. Soc. Ent. Fr., 86, p. 320.

Cephalothorax light-brown, longer than wide, more or less oval, truncated anteriorly; pars cephalica slightly raised, sloping gradually to the cervical groove, which is deep, recurved; from the cervical groove radiate eight furrows of a lighter colour; a short distance in front are two yellowish spots, from each of which projects a straight, upright, stout bristle; ocular area much broader than long, anterior row of eyes straight or nearly so (anterior margin of a.m.e. a little in front of that of a.l.e.); a.m.e. separated by less than their radius and by a diameter from a.l.e.; posterior row of eyes recurved; legs, short, stout; I. and II. tibia and metatarsus armed with fine irregular spines arranged in two lateral rows; tarsal claws curved but not hook-like; abdomen elongate-oval, covered with short hairs, no abdominal pattern; four spinnerets, inferior pair short, slender; superior pair stout, twice length of inferior pair.

*Distribution:* Type locality Mokohinau Islands. I have one specimen from this locality, but have no doubt that more will be available when the islands are again visited.

This species was described by Goyen from a female, but from his paper it appears that he captured several specimens. The spider builds its nest "on the bark of trees (Coprosma, Cordyline and Fagus)." Dalmas placed the species as a synonym of *Migas paradoxus* L. Koch, but it is now re-established as a good species. It differs from other species of *Migas* in the absence of the unique double row of stout, curved spines on the fore legs, in the closely placed a.m.e., the presence of two characteristic spines on the cephalothorax and in the length of the spinnerets.

The curvature of the anterior row of eyes in the species of this genus have been variously interpreted by different authors, due probably to a tangent to the eyes being considered in some cases and a median line in other cases.

## 3. **Sub-Order Hypochilomorphae.**

The Hypochilomorphae includes only two species, one from North Carolina and Tennessee, and the other from China. No specimens of this Sub-Order have been found in New Zealand.

# The occurrence of some Australian Insects and a Spider in New Zealand.

By D. SPILLER, Plant Diseases Division, Department of Scientific and Industrial Research, and

E. G. TURBOTT, Assistant Zoologist.

These notes concern the occurrence in New Zealand of five insects and a spider, four of which have not previously been recorded, while the rest are of special interest. Two of these are of importance as potential plant pests. Detailed descriptions of these insects are available in various publications and are not given in this paper.

## Class **INSECTA.**

### Order **DIPLURA.**

### Family **Japygidae.**

**Japyx tillyardi** Silv. 1930. New Record.

A single specimen of this insect was found under a small rotted log in the Waitakere Ranges, May 1941. Previously it was known from South Australia (Womersley, 1939). Tillyard (1924) mentions the occurrence of two species of this family in New Zealand, and the discovery of a species common to Australia and New Zealand is of interest as it seems improbable that specimens could have been accidentally introduced into the heart of the Waitakere Ranges, and we prefer to regard it as indigenous, but previously undiscovered. Dr. H. Womersley, who identified the specimen, remarked that the discovery was interesting, but not unexpected. The specimen is in the insect collection of the Plant Diseases Division.

### Order **HEMIPTERA.**

### Family **Pentatomidae.**

**Cuspicona simplex** Walker, 1867. New Record.

In September, 1939, many specimens of this green Pentatomid bug were collected from the foliage and fruit of *Solanum auriculatum* Ait. at Owairaka, Auckland. It has since been found to be widely distributed on the above host in Auckland, and has occurred on *Solanum sodomaeum* L. at Waiheke Island. It has also been taken on tomatoes at Remuera, New Plymouth and at Hokianga, at which latter place it was stated to be attacking the fruits as they turned colour and to be very abundant,

as many as a dozen bugs being on one fruit. Mr. A. Musgrave, of the Australian Museum, identified our specimens as *Cuspicona simplex* Walker, known from Queensland, New South Wales, South Australia (type locality) and from Tasmania. In Australia it has been recorded from *Solanum nigrum* L. and from potatoes (Tryon 1889, Froggatt 1901) and as attacking tomato fruits, causing these to become shrunken and small (Sloan 1941) although it is never regarded as a serious pest. The details of the life history do not appear to be known. This species can be readily separated from the other Pentatomid bugs known to occur in New Zealand by the green colour, medium size (length 11-12 mm.) and the sharply pointed lateral angles of the pronotum.

## Order **COLEOPTERA.**

### Family **Scarabaeidae.**

#### **Heteronychus sanctae-helenae** Blanchard, 1853.

A specimen of this beetle was sent to the Museum from Stanley Point, North Shore, Auckland, in December 1939, with the information that a swarm was doing considerable damage to the foliage of vegetables. Since then specimens have been seen from the original locality February, 1940, and from Waiheke Island, March 1937 and December 1942, these latter being collected by G. Chamberlain. The original specimen was misidentified in Australia as *Pentodon australis* (Blackburn), and this name was used by Cunningham (1940), who first recorded the pest in the Dominion.

The use of the name *P. australis* was later seen to be in error, as the males had enlarged and conspicuously unequal anterior claws which are characteristic of the genus *Heteronychus* Burm. In Jack's key (1924) our specimens run to *H. arator* Burm. (nec F) which Arrow (1937) has synonymised with *H. sanctae-helenae* Blanchard. The species is known from St. Helena; Cape Province, Rhodesia and the Transvaal in South Africa; East Africa; Abyssinia; Madagascar; and from New South Wales, Australia, where it is considered to have been recently introduced.

The adult beetle is an important pest of maize plants in Cape Colony (Jack 1924) and in the coastal district of New South Wales has caused considerable damage to maize, sugar cane and vegetable crops (McCarthy 1934, Anon 1939). In New Zealand there have as yet been no further reports of damage to crops or to pastures.

Mr. T. G. Campbell, Division of Economic Entomology, Canberra, checked our identification of *H. sanctae-helenae* and supplied the synonymy and the references to its economic status in Australia. The original specimen is in the Museum collection, while additional specimens—including a dissection of the male genitalia—are in the collection of the Plant Diseases Division.

## Order **LEPIDOPTERA.**

### Family **Nymphalidae.**

**Danaus melissa hamata** Mackay, 1827. New Record.

A single female specimen of this butterfly was found amongst tangled kumara foliage at Pakaraka, Bay of Islands, during March, 1940. No other occurrences of the butterfly have been reported and since it is in poor condition it possibly represents a straggler from Australia, where the species is common in Queensland and occurs rarely as far south as New South Wales. The typical species, *D. melissa melissa* Cramer occurs in Java, and various subspecies of the typical species occur in Australia; in the Samoan group (Hopkins 1927); in the Fijian group; in the New Hebrides, and in the Solomon Islands (Poulton 1924). Our specimen agrees well with the photographs of *D. m. hamata* W.S.M. given by Froggatt (1907), Waterhouse and Lyell (1914) and Tillyard (1926). It does not agree with the figures of Hopkins (1927), of the Samoan subspecies, or with those of Poulton (1924) of the Fijian subspecies. While we are quite satisfied with the above naming, the differences between the named subspecies sometimes appear trivial and a revision of the subspecific name may be required at a later date.

The specimen is in the collection of the Auckland Museum, where it was sent by its finder, Master Peter Ludbrook.

### Family **Noctuidae.**

**Dasypodia cymatoides** Guen.

This moth is common in the Auckland district, while the closely related *D. selenophora* Guen. is rare. In Otago, Sorensen (1939) found *D. selenophora* exclusively, while Hudson (1928) and (1939) regards *D. cymatoides* as rare.

The following specimens of *D. cymatoides* are in the Auckland Museum Collection: Auckland, March 1928; March 1930; March 1933.

In addition, over forty specimens have been taken during the last few years in the periods October-December and March-April, usually at rest on the walls of houses and buildings, but many have also been reared from pupae taken from under the dead bark and debris of *Albizzia lophantha* Benth., which is probably a host plant. They are not of any economic importance.

## Class **ARANEIDA.**

### Family **Clubionidae.**

**Isopeda insignis** (Thor.). 1870. New Record.

This spider is occasionally forwarded from the Mt. Albert and Avondale districts, to which it appears to be confined. This spider does not appear to have been recorded in New Zealand, although it has been present for many years, as shown by specimens in the Museum Collection

as follows: Mt. Albert, September 1924; January 1933; Avondale, February 1929; March 1938; January 1942; March 1942 (two specimens); March 1944.

The large size and hairy appearance, together with the habit of remaining motionless and fully extended on the walls of houses, have resulted in a good deal of misconception of the true nature of these spiders. They are usually regarded as dangerous, if not actually venomous, while in fact they are completely harmless and rather timid, without any means of defence.

The species is widespread throughout Australia, with a northern and southern form which are doubtfully distinct. The Australian representatives of the group have been treated by Hogg (1902), and in his key our specimens run easily to the above name. Dr. H. Womersley identified our material.

## ACKNOWLEDGEMENTS.

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VOL. 3. NO: 2.

# Revision of the Araneae of New Zealand.

## Part II.

By G. CHAMBERLAIN.

### 4. Sub-Order Dipneumonomorphae.

Araneae with non-segmented abdomen, one pair of book-lungs and one pair of tracheae. There may be a single or two tracheal spiracles. This Sub-Order contains the majority of the species occurring in New Zealand. The forty-nine or more families comprising the Dipneumonomorphae are divided into three Branches, (1) Trionychae, (2) Dionychae and (3) Quadrostiatae. The following key will serve to separate into families the spiders likely to be found in New Zealand.

**Key to Families Occurring in New Zealand.**

1. Abdomen with two pair of spiracles .................................. 2
   Abdomen with pair of spiracles leading into book-lungs followed by single median tracheal spiracle .................................. 3
2. Colulus present; pedipalp of female with claw .... Fam. Segestriidae
   Colulus absent; pedipalp of female without claw ...... Fam. Oonopidae
3. Three tarsal claws .................................. 4
   Two tarsal claws .................................. 21
4. Anal tubercle large, two-jointed, with a fringe of long hair. Cribellum and calamistrum present .................. Fam. Oecobiidae
   Anal tubercle normal .................................. 5
5. Cribellum and calamistrum present .................................. 6
   Cribellum and calamistrum wanting .................................. 9
6. Tarsi with or without claw-tufts, with or without scopulae. Cribellum divided or entire. Thoracic groove longitudinal. Chelicerae with boss. Lip free. Eight eyes in two rows, homogeneous, diurnal. Fam. Psechridae
   Tarsi without claw-tufts .................................. 7
7. Eyes homogeneous, diurnal. Cribellum entire. Tarsi without trichobothria. Femora and metatarsi with trichobothria. Eight eyes in two rows .................................. Fam. Uloboridae
   Eyes heterogeneous. Direct eyes alone diurnal .................. 8
8. Tarsi with single row of trichobothria; maxillary lobes more or less parallel; cribellum divided .................. Fam. Amaurobiidae
   Tarsi without trichobothria; maxillary lobes converging; cribellum usually entire .................................. Fam. Dictynidae
9. First and second tibia and metatarsus with a pro-row of long spines, interspaces with row of much shorter curved spines .... Fam. Mimetidae
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    No ventral "comb" on 4th tarsi .................................. 11
11. Chelicerae soldered together at base .................................. 12
    Chelicerae free .................................. 13

12. Tarsi normal with serrated bristles; eyes in three diads; lip long. Fam. Sicariidae
Tarsi long, flexible; indirect eyes in two triads; lip wide. Fam. Pholcidae
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Serrated bristles wanting on tarsi or not in shape of spurious claws .... 16
14. External surface of chelicerae with stridulating ridges .......... 15
Stridulating ridges on chelicerae wanting .......... Fam. Argiopidae
15. Pedipalp of female with claw. Male palpal tibia with no apophysis. Fam. Linyphiidae
Pedipalp of female without claw. Male palpal tibia with one or more apophyses .......... Fam. Micryphantidae
16. Chelicerae without boss; colulus absent .......... Fam. Zodariidae
Chelicerae with distinct boss .......... 17
17. Tarsal trichobothria in a regular row .......... 18
Tarsal trichobothria either in two rows or irregularly distributed ...... 19
18. All spinnerets in a transverse row .......... Fam. Hahniidae
Arrangement of spinnerets normal .......... Fam. Agelenidae
19. Only 4th trochanters with slight notch; posterior row of eyes strongly procurved .......... Fam. Oxyopidae
All trochanters strongly notched; posterior row of eyes recurved ...... 20
20. Superior claws with numerous teeth in single row; inferior claw with two or three teeth .......... Fam. Pisauridae
Superior claws with few teeth; inferior claw either smooth or with single tooth .......... Fam. Lycosidae
21. Eye formula 4-2-2; a.m.e. largest, p.m.e. smallest of the eyes. Fam. Attidae
Eyes either in two rows, or if in three rows, second row composed of four eyes, or else eyes distinctly heterogeneous .......... 22
22. Anterior pair of spinnerets wide apart .......... 23
Anterior pair of spinnerets contiguous or nearly so .......... 24
23. Retromargin of chelicerae either with a plate or lobes. Fam. Gnaphosidae
Retromargin of chelicerae smooth or with two teeth; sometimes legs laterigrade with 4th coxae longer than others .......... Fam. Drassidae
24. All tarsi without scopula; colulus present; chelicerae without scopula, margins usually smooth .......... Fam. Thomisidae
At least first and second tarsi with scopula; colulus absent; chelicerae with scopula, margins toothed .......... 25
25. Legs laterigrade; apical end of metatarsi with soft trilobate membrane. Fam. Sparassidae
Legs prograde; apical end of metatarsi with chitinous rim .......... 26
26. Eight eyes in two rows of four each; scopula of maxillary lobes not reaching over external surface .......... Fam. Clubionidae
Eight eyes in three rows; scopula of maxillary lobes partly extending over external surface .......... Fam. Ctenidae

## Branch **TRIONYCHAE.**

(Spiders with 3 pairs of cardiac ostia and 3 tarsal claws).

### Family **Oecobiidae.**

A specimen captured in 1935 at Waipoua probably belongs to this family. Unfortunately, however, the specimen is in a very badly damaged condition and it does not appear to be advisable to describe it at this stage. Perhaps further specimens will be obtained when the locality is again visited.

## Family Sicariidae.

**Key to Sub-Families Occurring in New Zealand.**

Eight eyes in two rows ............................ Sub-Fam. Plectreurinae
Six eyes in three diads ............................ Sub-Fam. Periegopinae

## Sub-Family Plectreurinae.

### Genus PLECTOPHANES Bryant, 1935.

1935 *Plectophanes* Bryant, *Rec. Cant. Mus., 4,* p. 81.

Type: P. FRONTALIS Bryant (Canterbury Museum Collection).

Thoracic groove longitudinal; chelicerae with boss, teeth on both margins of furrow; eight eyes in two rows, homogeneous, anterior row recurved, posterior row of eyes much larger than those of anterior row; abdomen and legs covered with a fine pubescence.

**Plectophanes frontalis Bryant, 1935.**

1935 *Plectophanes frontalis* Bryant, *Rec. Cant. Mus., 4,* p. 81, figs 10, 12, 14, 27.

(Type in Canterbury Museum Collection).

Cephalothorax brown, darkening on head, with thin covering of fine white hairs; eight eyes, anterior row beneath frontal lobe, strongly recurved, subequal; a.m.e. separated by about their radius, a.l.e. about four diameters from a.m.e.; posterior row of eyes recurved, eyes subequal, much larger than eyes of anterior row; p.m.e. separated by their diameter and from p.l.e. by $4\frac{1}{2}$ times their diameter; quadrangle of median eyes longer than wide, much narrowed in front, chelicerae dark brown with long hairs and bristles, with a boss; promargin of furrow with two teeth, the first the larger, retromargin with two teeth near base of the fang; legs (1, 2, 4, 3) yellowish; covered with fine hairs.

*Distribution:* Type locality Waikanae and also Wellington. I have captured one specimen on the Karori hills.

As suggested by Bryant, this species shows certain affinities with members of the family *Dysderidae* and at present its Sub-Family status is in doubt.

## Sub-Family Periogopinae.

### Genus PERIEGOPS Simon, 1893.

1893 *Periegops* Simon, *Hist. Nat. Ar., 1,* p. 267.

Type: P. HIRSUTUS Simon.

Cephalothorax convex, not attenuated; front wide and blunt, head not distinct; six eyes, small and equal, in three diads, widely separated and occupying total width of front; clypeus broad, slightly convex; chelicerae robust, retromargin with carinas, promargin elevated with three large teeth; labium much longer than wide, blunt, convex; maxillary lobes long, parallel, pointed in an oblique manner; legs (4, 1, 2, 3), not spined but with rigid setae; three tarsal claws, superior claws pectinate in a double row; abdomen oval, inferior spinnerets robust and short.

### Periegops suteri (Urquhart), 1891.

1891 *Segestria suteri* Urquhart, *Trans. N.Z. Inst., 24.* p. 230 (♀).
1893 *Periegops hirsutus* Simon, *Hist. Nat. Ar., 1,* p. 267 (Genotype).
1917 *P. hirsutus,* Dalmas, *Ann. Soc. ent. Fr.* 86, p. 317.
1935 *P. suteri,* Bryant, *Rec. Cant. Mus., 4,* p. 53-70.
1939 *P. suteri,* Bryant, loc. cit. p. 71-93, figs. 4, 13, 25 (♂)

(Allotype male in Canterbury Museum Collection).

Cephalothorax yellow brown, darkening on head; thoracic groove absent; six eyes, very small, subequal, nocturnal, in three widely separated diads; chelicerae brown with few long white hairs; retromargin with two carinas, the anterior ending at fang groove with tooth on promargin; fang short with very thick base; maxillary lobes one-third longer than labium more or less parallel, curved over lip; sternum oval, two-thirds as wide as long; legs (4, 1, 2, 3) light brown, clothed with rows of stiff hairs; first three pairs directed forwards; abdomen light yellow-brown clothed with stiff hairs, ovoid.

*Distribution:* Type localities Dyer's Pass and Port Hills, both in Canterbury. This species appears to be confined to the northern half of the South Island.

*P. hirsutus* Simon is placed as a synonym after examining a specimen so labelled by Dalmas.

## Family **Pholcidae.**

## Sub-Family **Pholcinae.**

## Genus **PHOLCUS** Walckenaer, 1805

1805 *Pholcus* Walckenaer, Tabl. Aran., p. 80.

Type: P. PHALANGIOIDES (Fuesslin).

Anterior row of eyes in straight line, medians at least a third smaller than laterals, themselves subcontiguous but their width from the laterals. Posterior eyes on both sides contiguous. Median area trapeziform, much broader than long. Clypeus more than three times width of ocular area and depressed a little below the eyes, then obliquely downwards. Chelicerae forming chelate structure.

### Pholcus phalangioides (Fuesslin).

1917 *P. phalangioidess* Dalmas, *Ann. Soc. ent. Fr., 86,* p. 317.

Eight eyes; a.m.e. set on tubercle, subcontiguous, smallest of the eyes; a.l.e. largest of eyes, each set on tubercle together with corresponding posterior eyes; contiguous with p.l.e., subcontiguous with p.m.e.; posterior row of eyes slightly recurved, equal, nocturnal; chelicerae of a chelate structure; spinnerets eight, terminal; legs very long, thin; epigynum distinctive.

*Distribution:* Cosmopolitan, introduced. This is probably the most abundant species in New Zealand.

This spider generally inhabits dwellings and is rarely found in an uninhabited area. It is commonly referred to as "daddy long-legs," although this name is more correctly applied to the Phalangida.

## Family Mimetidae.

### Sub-Family Mimetinae.

### Genus MIMETUS Hentz, 1832.

1832 *Mimetus* Hentz, *Sillim. Jour., 41,* p. 99.

Type: M. INTERFECTOR Hentz.

Cephalothorax long, moderately convex; median ocular area not longer than broad and much wider anteriorly than posteriorly; laterals not very far from medians; clypeus much narrower than ocular area but wider than a.m.e.; chelicerae long; labium much longer than wide, point attenuated and obtuse; maxillary lobes narrow and long, converging; legs long, unequal, spined, tibia and metatarsis of anterior legs typically so; abdomen convex, commonly with angular prominence.

**Key to New Zealand Species.**

P.m.e. separated by half their diameter and from p.l.e. by more than diameter .................................... *M. mendicus* Cambridge
P.m.e. separated by their diameter and from p.l.e. by less than diameter. *M. senio* (Urquhart)

**Mimetus mendicus** Cambridge, 1879.

1879 *Mimetus mendicus* Cambridge, *Proc. Zool. Soc.,* p. 697, pl. 53, fig. 14 (♀).
1891 *M. atri-cinctum* Urquhart, *Trans N.Z. Inst., 24,* p. 234 (♂).
1917 *M. atro-cinctus:* Dalmas, *Ann. Soc. ent. Fr., 86,* p. 317.
1917 *M. mendicus:* Dalmas, *loc. cit. supra.*
1937 *M. mendicus:* Bryant, *Rec. Cant. Mus., 4,* p. 71, fig. 28, 29.

Cephalothorax small, pale yellow, elongate oval; eyes eight, anterior row recurved, subequal, a.m.e. on tubercle, separated by their diameter and from a.l.e. by more than diameter; posterior row procurved, subequal, p.m.e. separated by half diameter and from p.l.e. by more than diameter; laterals contiguous; median ocular area almost square, a little longer than wide and a little narrower posteriorly than anteriorly; clypeus vertical, near the height of median ocular area; legs 1, 4, 2, 3; anterior four very long and typically spined, first femur with broken dark rings; sternum oval, truncated anteriorly; abdomen whitish mottled with dark grey, convex above with typical blunted tubercles.

*Distribution:* Uncommon but found in both Islands.

The *Mimetidae* were formerly placed with the *Theridiidae,* indeed the two species occurring in New Zealand appear at first sight to be a *Theridion.*

**Mimetus senio** (Urquhart), 1890.

1890 *Linyphia senio* Urquhart, *Trans. N.Z. Inst., 23,* p. 137, pl. 21, fig. 15, 16.
1917 *Mimetus senio:* Dalmas, *Ann. Soc. ent. Fr., 86,* p. 317.

Cephalothorax dark orange; posterior row of eyes procurved, p.m.e. separated by their diameter and from p.l.e. by less than diameter; anterior row of eyes recurved, a.m.e. larger than p.m.e. separated by diameter and from a.l.e. by a little more than half a diameter; a.l.e. smallest of the eyes.

*Distribution:* Type locality Stratford.

## Family Uloboridae.
## Sub-Family Uloborinae.
## Genus ULOBORUS Latreille, 1806.

1806. *Uloborus* Latreille. *Gen. Crust. Ins., 1,* p. 109.

Type: U. WALCKENAERIUS Latr.

Posterior eyes small, equal in more or less recurved line, medians separated by about same as from laterals. Anterior eyes in slightly procurved line, medians from laterals a little more than between themselves. Median ocular area longer than wide, occasionally equal length and width, anteriorly a little narrower than posteriorly, a.m.e. nearly always the greater. Legs 1, 4, 2, 3, sparingly armed with short spines. Anterior metatarsi thin, longer than patella plus tibia. Calamistrum at apex of metatarsi. Abdomen pointed posteriorly and spinnerets terminal.

### Uloborus waitakerensis n. sp. Figs. 1-4.

*Female* (Holotype). Total length from posterior end of abdomen to anterior end of cephalothorax 3.33 mm. Carapace 1.17 mm. long, 0.94 mm. wide in middle of head, 1.06 mm. wide between second and third coxae where it is widest. The carapace is almost circular. The sides of the head slope towards the geometrical centre of the carapace forming a short flattened cone with the base directed forwards. Thoracic groove indicated by a very slight shallow depression. Carapace truncated on posterior edge, which is recurved to take the articulation of the pedicle.

Head only slightly raised above the thorax commencing at about the mid-point of the carapace and maintaining a level dorsal surface in contrast to the more or less evenly sloping sides of the remainder of the carapace.

Eight eyes in two rows, homogeneous, diurnal. When viewed from above both rows appear parallel, recurved. View from the front the anterior row of eyes is procurved. Width of anterior row of eyes 0.61 mm., of the posterior row 0.67 mm.

Ratio of eyes A.M.E.: A.L.E.: P.M.E.: P.L.E. = 7: 6: 8: 6.

The a.m.e. are separated from each other by one and a half times the diameter of the a.l.e. which are separated by their diameter from the a.m.e. The p.m.e. are separated from each other by one and a fifth times their diameter and from the p.l.e. by three-quarters their diameter.

Quadrangle of median eyes wider behind than in front in the ratio 10: 9, longer than wide in ratio 20: 9.

All the eyes are set in black rings. Clypeus 0.08 mm. high.

Chelicera with boss. No teeth are visible on the margins. The aperture of the poison duct could not be detected.

Lip free, as wide as long. The lip is roughly oval, passing anteriorly into a small acute projection. The end of the lip does not quite reach the middle of the visible length of the maxillae. At the sides it slightly overlaps the lobe of the maxillae.

Maxillae with sides more or less parallel, the ventral surface of each lobe with 7 short stiff hairs or bristles. Scopulae absent. The maxillae are articulated slightly above and beneath the sternal plate.

Sternum longer than wide. Widest at level of first pair of legs narrowing posteriorly. Fourth coxae separated by sternum.

Fourth coxae heavier than remainder and as long as the first, which are about one and a half times the length of the second and third. The coxae are more or less evenly spaced.

| | 1 | 4 | 2 | 3 |
|---|---|---|---|---|
| Leg Formula | 6.6 | 4.5 | 3.6 | 2.5 |

| | *Femur* | *Pat. & Tibia* | *Metatarsus* | *Tarsus* | *Total* |
|---|---|---|---|---|---|
| I | 2.11 | 2.44 | 2.11 | 1.06 | 7.72 |
| II | 1.28 | 1.33 | 1.00 | 0.61 | 4.22 |
| III | 0.94 | 0.89 | 0.61 | 0.43 | 2.87 |
| IV | 1.56 | 1.61 | 1.22 | 0.89 | 5.28 |

Width of first patella 0.240 mm. First tibial index 9.8.
Width of Fourth patella 0.192 mm. Fourth tibial index 11.9.

Palp. Femur dorsal 0.30; Patella ventral 0.03, dorsal 0.13; Tibia ventral 0.11, dorsal 0.13; Tarsus 0.40.

Spines. First leg. Femur dorsal 0-0-1; Tibia prolateral 0-1-1, retrolateral 0-0-1; Metatarsus dorsal 2-1-1, retrolateral 0-1-0.
Second leg. Femur dorsal 0-1-0; Patella dorsal 1-1; Tibia dorsal 1-0-0.
Third leg. Patella dorsal 1-1; Metatarsus ventral 0-0-2.
Fourth leg. Tibia dorsal 0-1-0, prolateral 0-0-1; Metatarsus ventral 0-0-2, prolateral 1-1-1; Tarsus 0-1-0.
Elsewhere nil.

Trichobothria. First leg 0. Second leg. Femur 1-1-2 in proximal half. Tibia 2 about halfway. Third leg. Trochanter 1. Femur prolateral row of 7 in proximal three-quarters of joint. Tibia 2. Fourth leg. Trochanter 2. Femur prolateral row of 12 along length of segment. Tibia 4 scattered.

Calamistrum occupying a little more than a third the length of the 4th metatarsus, consisting of about 22 bristles of moderate length.

Abdomen ovoid, humped anteriorly. Cribellum undivided. Spinnerets six, terminal. Anterior pair of spinnerets widely separated, set at each end of cribellum. Basal joint large, sparsely clothed with black hair. Terminal joint small. Median pair short and slender, contiguous, half length of anterior pair. Posterior pair same length or very slightly larger than anterior pair. Terminal joint cone shaped.

Epigynum in form of indistinct equilateral triangle with an opening set below each end of the base, deeply set in the furrow.

Colour in alcohol. General appearance mottled yellow grey. Abdomen with a background of grey black, patches of dull white very numerous on dorsal surface, less as ventral aspect is approached. Ventral surface with two longitudinal rows of white passing from outer edges of epigynum to middle of

abdomen. Cephalothorax yellow brown with median wide longitudinal band of grey-black passing from pedicle to just behind posterior row of eyes. A triangle of yellow brown with base on the p.m.e. cuts back into this band. Legs yellowish interspaced with wide rings of grey-black. Rings more numerous on fourth pair of legs.

Four females of this species were captured on the Watershed Reserve, Waitakere hills, Auckland. One of these is the holotype described above. The others are cotypes, one of which is immature. The holotype and one cotype are in the author's collection. Two cotypes are deposited in the Auckland Museum collection.

## Family **Dictynidae.**

### Sub-Family **Dictyninae.**

### Genus **DICTYNA** Sundevall, 1833.

1833 *Dictyna* Sundevall, *Consp. Arachn.*, p. 16.

Type: D. ARUNDINACEA L.

Anterior row of eyes straight, nearly equidistant, equal or a.m.e. a little smaller. Posterior eyes minute, equal and widely separated, in a slightly recurved line. Median ocular area trapeziform (anterior a little narrower), either square or not much longer than wide. Lateral eyes subcontiguous. Clypeus much wider than anterior eyes. Labium longer than broad. Cribellum divided or entire.

#### Key to New Zealand Species.

Boss of chelicera very prominent, raised in form of a tooth *D. cornigera Dalmas*

Boss of chelicera not prominent as above .......... *D. decolora* (Urquhart)

### **Dictyna cornigera** Dalmas, 1918.

1918 *D. cornigera* Dalmas, *Ann. Soc. Ent. France, 86*, p. 336, figs. 9-12.

Cephalothorax chestnut, gradually darkening anteriorly; abdomen mouse-grey; eyes generically normal; clypeus slightly concave, raised anteriorly; chelicerae contracted in middle, leaving between them a hollow in form of a prolonged diamond; boss long, not attentuated, towards centre of superior face, producing a tooth-like angular projection on front of clypeus; fang stout and long, superior margin armed with strong teeth towards extremity; cribellum entire; calamistrum entire; calamistrum occupies more than half of the joint.

*Distribution:* Type locality Temuka. The Auckland Museum collection contains an immature female captured in Taranaki which may be of this species.

### **Dictyna decolora** (Urquhart), 1893.

1893 *Linyphia decolor* Urquhart, *Trans. N.Z. Inst., 26*, p. 208.
1918 *Dictyna nigella* Dalmas, *Ann. Soc. Ent. France, 86*, p. 338, fig 13.
1935 *Dictyna decolor:* Bryant, *Rec. Cant. Mus., 4*, p. 1.

A suitable description of this species is given by Urquhart, but of course the presence of cribellum and calamistrum were not noticed at the time. Size smaller than previous species; a.m.e. smaller and a.l.e. larger. Chelicera almost normal without a very prominent boss.

*Distribution:* Uncommon, but found in both Islands.

## Family **Micryphantidae.**
## Sub-Family **Erigoninae.**

### Key to Genera Occurring in New Zealand.

Anterior median eyes subcontiguous .................. Genus *Diplocephalus.*
Anterior median eyes separated ..........................Genus *Erigone*

## Genus **DIPLOCEPHALUS** Bertkau, 1883.

1883 *Diplocephalus* Bertkau, *Beitr. z. Kennt. Sp. Reinp.*

Type: D. CRISTATUS (Blackwall).

Posterior eyes quite large or moderate, in a straight line or more or less procurved, equidistant or rarely medians farther from laterals than between themselves (interocular space rarely wider than eyes). Anterior eyes in a straight line, medians subcontiguous but well separated from laterals. Median area trapeziform, larger than wide. Clypeus almost equal to eye space.

### **Diplocephalus cristatus** (Blackwall), 1833.

1833 *Walckenaera cristatus* Blackwall, *Lond. & Edin. Mag., 3.* p. 107.
1879 *Walckenaera cristatus:* Cambridge, *Proc. Zool. Soc.,* p. 693.
1883 *Diplocephalus cristatus:* Bertkau, *Beitr. z. Kennt. Sp. Reinp.*
1918 *Diplocephalus cristatus:* Dalmas, *Ann. Soc. Ent. Fr., 86,* p. 317.

This species was first recorded from New Zealand by Cambridge in a series of specimens collected by Mr. Atkinson.

I have not found this species in New Zealand.

## Genus **ERIGONE** Audouin.

1827. *Erigone Audouin,* in *Sav., Egypt. Ar.,* 1825-27.

Type: E. VAGANS Audouin.

Margin of cephalothorax obtuse, head convex, front broad. Posterior eyes moderate sized, equal and about equidistant. Anterior eyes in straight line or scarcely procurved, medians farther from laterals than between themselves. Median area not or scarcely longer than wide. Clypeus flat, wider than ocular area. Legs medium, tibia quite strongly armed. Margin of cephalothorax, exterior margin of chelicera and sometimes anterior femora, very often with serrated teeth.

### **Erigone atriventer** Urquhart, 1886.

1886 *Erigone atriventer* Urquhart, *Trans. N.Z. Inst., 19,* p. 102.
1935 *Erigone atriventer:* Bryant, *Rec. Cant. Mus., 4,* p. 1-26, fig. 26.
1918 *Erigone atriventer:* Dalmas, *Ann. Soc. ent. France, 86,* p. 317.

This species was described from a female specimen found at Karaka. The type is in a very poor condition but is preserved in the Canterbury Museum collection. Both Dalmas and Bryant doubt the generic status of the species, but, as stated by Bryant, the correct genus cannot be established until a male is described. It is unfortunate that a number of the genera of this sub-family have been established on characters peculiar to the male.

This species is not represented (other than by the type) in any of the collections examined.

## Family **Psechridae.**

### Sub-Family **Matachiinae.**

### Genus **MATACHIA** Dalmas, 1918.

1918 *Matachia* Dalmas, *Ann. Soc. ent. France, 86,* p. 326.
1942 *Matachia:* Petrunkevitch, *Trans. Conn. Acad. Arts Sci., 34,* p. 221.

Type: M. RAMULICOLA Dalmas.

Claw-tufts wanting; cribellum entire; lip long; eyes subequal, anterior medians slightly smaller, separated from each other by about their diameter, posterior medians by much more than their diameter; anterior row of eyes slightly recurved, posterior row slightly procurved; quadrangle of median eyes much wider than long, wider behind than in front; legs (1, 2, 4, 3); calamistrum not reaching beyond two-thirds of metatarsus.

**Key to Species Occurring in New Zealand.**

Eyes subequal, a.m.e. slightly smaller ................ *M. ramulicola Dalmas*
Eyes subequal, p.m.e. slightly smaller .................. *M. rufoflavus* n. sp.

### **Matachia ramulicola** Dalmas, 1918.

1918 *Matachia ramulicola* Dalmas, *Ann. Soc. ent. France, 86,* p. 328, figs. 1-4.

Cephalothorax oval, slightly elevated; thoracic groove very short, transverse; head light red in colour, long, slightly broadened in front; ocular group wide, occupying two-thirds of the front; anterior row of eyes slightly recurved, posterior row slightly procurved; eyes more or less subequal, a.m.e. slightly smaller, laterals subcontiguous but widely separated from medians; median ocular area wider than long and wider behind than in front; clypeus very narrow; chelicerae thick, projecting in front; inferior margin with two small granulations, superior margin with four small teeth, equal except the second from the base which is twice size of others; legs (1, 2, 4, 3), four anterior much longer than others; calamistrum in single line occupying a little more than half length of metatarsus; abdomen elongate subcylindrical; cribellum entire almost as wide as group of spinnerets.

*Distribution:* Type locality Matakitaki River, Nelson.

### **Matachia rufoflavus** n. sp. Figs. 5-10.

*Female* (Holotype). Total length 2.39 mm. Carapace 1.06 mm. long, 0.78mm. wide between second and third coxae, where it is widest. The thoracic portion is almost circular, truncated posteriorly; cephalic portion rectangular in horizontal section, more or less hemicylinderical in form. Thoracic groove very small, shallow, transverse.

Head in profile horizontal, sides of thorax sloping evenly so that head is somewhat raised above thorax.

Eight eyes in two rows, heterogeneous, a.m.e. alone diurnal. The posterior row is slightly longer than the anterior row, lateral eyes subcontiguous. Viewed from above, the anterior row is slightly recurved, the posterior row slightly procurved. Full width of eye group 0.32mm.

Ratio of eyes, A.M.E.: A.L.E.: P.M.E.: P.L.E. = 3: 3: 2: 3.

The a.m.e. separated from each other by two-thirds of their diameter and the same distance from the a.l.e. P.m.e. separated from each other by one and two-thirds the diameter of the a.m.e., and the same distance from the p.l.e.

Quadrangle of medians wider behind than in front in ratio 9: 8, wider than long in ratio 8.5 : 8.

All the eyes are set in black rings, the laterals set on slight tubercles.

Clypeus about twice diameter of a.m.e.

Chelicerae with sides parallel, articulated directly under anterior row of eyes. Promargin with two teeth and retromargin with one tooth set as shown in the figure. Inner edge of paturon with a distinct mastidion.

Lip free, as wide as long, sides slightly overlapping maxillary lobes.

Maxillary lobes with sides parallel, not inclined over lip and with distinct serrula.

Sternum more or less pear-shaped, narrowing posteriorly.

Coxae of about equal size and length. Fourth coxae partly separated by the narrowed posterior portion of the sternum.

| | 1 | 2 | 4 | 3 |
|---|---|---|---|---|
| Leg Formula | 2.9 | 2.5 | 2.3 | 2.2 |

| | *Femur* | *Pat. & Tibia* | *Metatarsus* | *Tarsus* | *Total* |
|---|---|---|---|---|---|
| I | 0.94 | 1.00 | 0.72 | 0.39 | 3.05 |
| II | 0.83 | 0.89 | 0.56 | 0.39 | 2.67 |
| III | 0.72 | 0.83 | 0.50 | 0.33 | 2.38 |
| IV | 0.78 | 0.83 | 0.50 | 0.33 | 2.44 |

Width of first patella 0.14 mm. First tibial index 14.
Width of fourth patella 0.13 mm. Fourth tibial index 16.

Palp. Total length extends to end of femur of first leg.

Spines. Third leg. Patella dorsal 1 at proximal end. Tibia dorsal 2 at proximal end. Metatarsus ventral 2 at distal end. Fourth leg as for third but with only one spine on the tibia. Elsewhere nil.

Calamistrum 0.32 mm., occupying a little less than two-thirds of the length of the metatarsus.

Abdomen elongate oval as shown in figure. Cribellum entire, wide, occupying same width as the group of six spinnerets.

Epigynum as figured.

Colour in alcohol. General appearance yellow. Cephalothorax of even dulled yellow (brilliant yellow in living specimen). Abdomen with bright yellow background becoming dulled and lighter in colour towards lateral and ventral surfaces. At posterior end of abdomen there is an irregular shaped patch of bright cardinal red. The upper lateral and dorsal surfaces are speckled with opalescent white patches (not present in living specimen). The posterior red patch appears at the penultimate instar.

*Male* (Allotype). Total length 2.50 mm. Carapace 1.22 mm. long, 0.83 mm. wide between second and third coxae where it is widest. The contour of the cephalothorax is similar to that of the female except that the thoracic groove is very difficult to see. Head similar to that of female.

Eyes, eight in two rows, heterogeneous, a.m.e. diurnal directed forwards. The lateral eyes are subcontiguous, more so than in female. When viewed from above the anterior row is slightly recurved and the posterior row slightly procurved. Full width of eye group 0.40 mm.

Ratio of eyes, A.M.E.: A.L.E.: P.M.E.: P.L.E. = 4: 4: 3: 4.

The a.m.e. separated from each other by half their diameter and the same distance from the a.l.e. P.m.e. separated by one and two-thirds their diameter and the same distance from the p.l.e.

Quadrangle of median eyes wider behind than in front in ratio 10: 9, wider than long in ratio 9.5: 8.

All the eyes are set in black rings as in the female.

Clypeus, chelicerae, maxillary lobes, sternum and coxae similar to those of female.

Lip free, wider than long in ratio 17: 12, slightly overlapping the maxillary lobes.

| Leg Formula | 1 | 2 | 4 | 3 |
|---|---|---|---|---|
| | 3.0 | 2.8 | 2.1 | 2.0 |

| | *Femur* | *Pat.& Tibia* | *Metatarsus* | *Tarsus* | *Total* |
|---|---|---|---|---|---|
| I | 1.17 | 1.28 | 0.83 | 0.39 | 3.67 |
| II | 1.11 | 1.11 | 0.78 | 0.39 | 3.39 |
| III | 0.72 | 0.78 | 0.67 | 0.33 | 2.50 |
| IV | 0.67 | 0.89 | 0.67 | 0.33 | 2.56 |

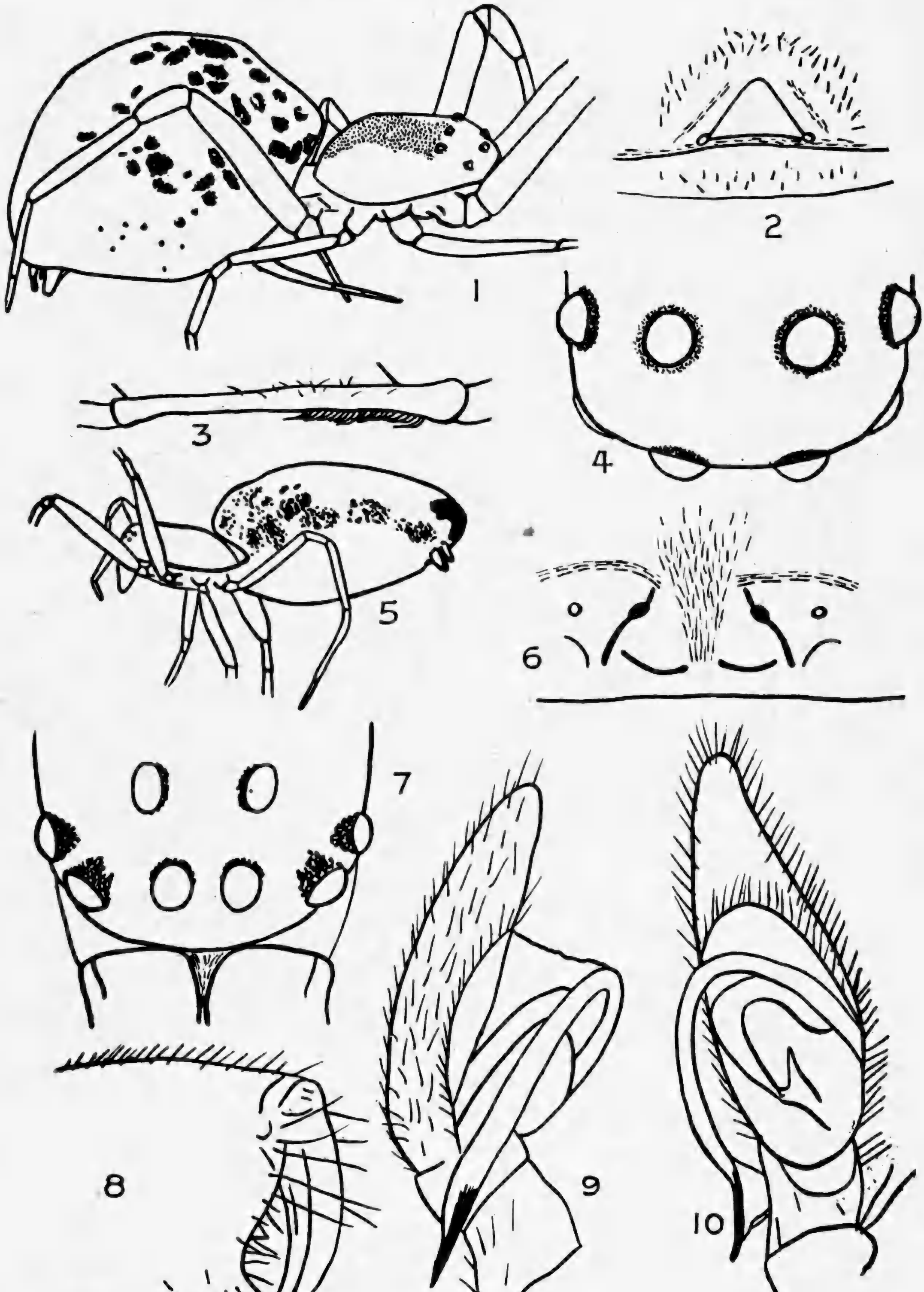
Width of first patella 0.16 mm. First tibial index 13.
Width of fourth patella 0.14 mm. Fourth tibial index 16.

Palp extends to end of femur of first leg. Terminal joint as figured.

Spines. Third leg. Patella dorsal 1 at proximal end. Tibia dorsal 2 at proximal end. Metatarsus ventral 2 at distal end.
Fourth leg as for third, but only 1 proximal spine on tibia.
Elsewhere nil.

Colour in alcohol. Similar to female but cephalothorax dulled with a tint of brown. Chelicerae light brown. Posterior red patch on the abdomen is not always present.

Two males and two females were captured on Waiheke Island, Auckland, where they live on low tea-tree bushes. One pair of these, the holotype female and allotype male, described above, are in the author's collection. The other pair, designated as cotypes, are deposited in the Auckland Museum collection.



*Uloborus waitakerensis* n. sp. Fig. 1. Lateral view; 2. epigynum; 3. calamistrum; 4. disposition of eyes.

*Matachia rufoflavus* n.sp. Fig. 5. Lateral view; 6. epigynum; 7. disposition of eyes; 8. chelicera, front view; 9. male palp, lateral view; 10. male palp, ventral view.

# The Paryphantidae of New Zealand.

## No. V. Further New Species of Paryphanta, Wainuia and Rhytida.

By A. W. B. POWELL, Acting Director.

In the first issue of the Records of the Auckland Institute and Museum ((1930) the writer published a review of the New Zealand members of the *Paryphantidae,* which comprises five genera, *Rhytida, Paryphanta, Wainuia, Schizoglossa* and *Delos.* A number of new species and subspecies were described, and in three supplements (1932, 1936 and 1938) further new forms were proposed. The present supplement, Part 5, adds another fifteen new species and subspecies, bringing the total for the family to sixty-two.

In the original review it was stated, in reference to the genus *Paryphanta,* "that continuous land is necessary for dispersal and that the species must have developed approximately within or close to the areas they now occupy, and that topographic features, such as mountain ranges, river systems and islands, have played and are still playing an important part in the segregation and evolution of species."

Since the above was written certain areas, particularly the Levin district, have been subjected to fairly complete field survey, and the results are fully in accord with the statement made in 1930. In fact wherever subsequent work is done the tendency is to narrow the distribution of a species by the finding of self-contained subspecific forms within the range of that species. In all such cases an existing topographic barrier or evidence of some such past feature is almost invariably shown to operate, or to have operated, as the segregating influence. Thus the finding of a new species of *Paryphanta* typical from the Aupourian of the extreme north together with the fact that the *Rhytida* and *Placostylus* snails of this area are restricted also, is evidence that this northern extremity must have been long isolated by water from the rest of the North Auckland Peninsula. Under present conditions the country connecting the northern extremity with the rest of the North Auckland Peninsula is largely sand dunes, and is without the necessary forest cover.

A good example of imperfect segregation of subspecific forms is shown by *traversi traversi* and *traversi florida* n. subsp. It is assumed that these two subspecies developed respectively, north and south of the Ohau River, but owing to past changes in the course of that river a buffer zone of mixed colonies occurs.

No very satisfactory classification of races of land snails has been devised as yet. Specific and subspecific designation is in actual practice too rigid to achieve complete uniformity in values. It is the constant stumbling block of all taxonomic work—the application of a rigid nomenclature to animals which are not wholly rigid or stable in their make up.

Some opinions of Dr. H. A. Pilsbry, the greatest living authority on land mollusca, are worthy of note (1939, Land Mollusca of North America, Monograph 3, Acad. Nat. Sci. Phil. Vol. 1, Pt. 1, pp. XIV and XV):

"Subspecies are theoretically races showing some intergradation with neighbouring forms in a small proportion of the individuals, but characterized by having a definably different distribution, geographic or ecologic. This distribution may be contiguous to that of conspecific races, or it may be isolated by geologic, climatic or other conditions, as when races are confined to calcareous soils, to humid places in an arid region, or are insular. Most subspecies are recognizably differentiated populations which are not considered sufficiently distinct to be called species. They are merely incipient species, in which the discontinuity is incomplete, or is not strongly pronounced."

"The term '*forma*' has also been used for forms which show some differentiation, consistent in the colony, but either below the grade usually associated with subspecies, or restricted to single or a few colonies, thus having a much narrower range than is usually covered by a subspecies and without noticeable difference in the local conditions 'Forms' or 'little races' of this kind are numerous in *Oreohelix*. They seem to be equivalent to the 'microgeographic species' of Dobzhansky."

By the above criteria many of the *Paryphanta* colonies in artificially isolated remnants of the original forest cover both on the plain around Levin and in the low country of West Haven Inlet, Nelson, are beginning to exhibit individual characteristics and ultimately they may acquire sufficient distinction to be regarded as forms or even subspecies.

The writer's action in applying subspecific names to colonies which are separable from other colonies merely on account of different coloration is open to criticism. Justification for this action is the fact that these differences in coloration are characteristic for a definable area segregated by topographic boundaries. Thus these colour differences are not merely varying factors that may occur in any breeding colony.

The *Paryphanta* animal is a sensitive creature and cannot adjust itself to a wide range of conditions. More or less continual dampness is essential, and since their food consists mainly of earthworms, there are many parts of the forest unsuitable to worms and snails alike.

## ACKNOWLEDGMENTS.

Several people have contributed very largely to this paper with detailed field work. They are Messrs. R. A. and H. S. Prouse of Levin, Mr. A. C. O'Connor of Wellington and Mr. W. H. Johnston of Seddonville. The Prouse cousins carried out a thorough survey of the Horowhenua District from Otaki to Tokomaru, as well as considerable work in West Nelson areas. Mr. O'Connor made available the results of his numerous field trips over the past five years, and generously donated to this Museum material for the selection of type specimens. Mr. Johnston made a careful search for new localities in the Seddonville area, which resulted in the finding of a new subspecies. Others have

helped with material and information. They are Dr. R. A. Falla, Director, Canterbury Museum, Mr. W. Harris and Miss L. B. Moore, Wellington, Mrs. M. Mouat, Auckland, Mr. A. Richardson, Papakura, Mr. A. Harvey, Collingwood, Mr. A. G. Stevenson, Auckland, Mr. A. H. Watt, Parengarenga, Mrs. I. Worthy, Patumahoe, and Mr. A. J. Evans of Onekaka.

The writer is especially indebted to the Prouse cousins, not only for field data and the fine material presented to the Auckland Museum as the direct result of their survey, but also for the efforts they are making to preserve restricted colonies from destruction. The fact that four colonies of these snails occur on their respective properties at Levin and in West Nelson is the best assurance we have that these restricted colonies will have every possible chance of survival.

## Genus **PARYPHANTA** Albers, 1850.

### Subgenus **PARYPHANTA** Albers, 1850.

Type (Monotypy): HELIX BUSBYI Gray.

Typical *Paryphanta* is now restricted to the genotype and an allied new species which is described below. These two species differ from the subgenus *Powelliphanta* O'Connor, 1945, by having a substantial limy shell underlying a heavy and almost uniformly dark coloured coating of conchin. The last half-whorl shows considerable acceleration and the egg is thick-shelled, white and limy, without a cuticle. (See A. C. O'Connor, 1945, Trans. Roy. Soc. N.Z. 75, pp. 54-56.)

**Paryphanta busbyi** (Gray, 1840) Pl. 9, fig. 1. Text fig. A6.

The well-known North Auckland Kauri snail still exists in scattered forest reserves from the Kaipara district to the vicinity of Kaitaia. It occurs also without change on the outlying islands of the Poor Knights (Tawhati Rahi) and Taranga or Hen Island, but the occurrences from the extreme north of the North Auckland Peninsula are specifically distinct and have evidently diverged as the result of long isolation.

**Paryphanta watti** n. sp. Pl. 9, fig. 2. Text fig. A5.

Compared with *busbyi* this new species is smaller, more depressed, has a more shallow body-whorl, the addition of radial wrinkles between the spiral cords and a distinctive coloration. It is never greenish, but ranges in colour between tawny-olive and olive-citrine on the spire whorls to a warm black over most of the body-whorl. The spiral cords, nine or ten in number, fade out over the last half-whorl as in the genotype. Protoconch with indistinct arcuate radials; early spire-whorls with dense irregular malleations; body-whorl with closely spaced arcuate to chevron-shaped radials between the spiral cords.

The species does not grow so large as *busbyi*, even the 53.5 mm. example of *watti* has an adult lip, but *busbyi* of this size is definitely juvenile.

| Major diameter: | Minimum diameter: | Height: | Depth of body-whorl* | |
|---|---|---|---|---|
| 78.5 m.m. | 61.5 mm. | 42.0 mm. | 32.0 mm. | (*busbyi*, large example, near Dargaville) |
| 62.5 mm. | 47.5 mm. | 33.5 mm. | 26.5 mm. | (*busbyi*, Hokianga) |
| 62.0 mm. | 46.0 mm. | 31.0 mm. | 23.5 mm. | (*watti*, holotype) |
| 56.0 mm. | 42.0 mm. | 27.5 mm. | 24.0 mm. | (*watti*, paratype) |
| 53.5 mm. | 41.5 mm. | 27.0 mm. | 22.0 mm. | (*watti*, paratype) |

Dimensions of an egg taken at Unuwhao, 14 mm. x 11 mm. It has a rough limy shell without a cuticle as in *busbyi*.

*Measurement in this case is taken at the extreme left, directly opposite termination of last whorl. This is on account of the rapid increase in the whorl-height at the usual place in front of the body-whorl.

*Localities:* Unuwhao, 900 feet, near track between Spirits Bay and Tom Bowling Bay, under decaying leaves in coastal forest (type); Kahuronaki (Kahuroa on survey maps) between Te Paki and the Kapo Wairua Road (A.W.B.P., Feb., 1944); Cape Maria van Diemen mainland, consolidated dunes underlying the Recent dunes, with *Placostylus ambagiosus priscus* Powell, 1938; probably Pleistocene.

*Holotype:* Auckland Museum.

The finding of a distinct species of the *busbyi* group from the Cape Maria-North Cape block is of interest since *busbyi* typical shows no variation over the remainder of the North Auckland Peninsula. Nor does it vary from the outlying islands, the Poor Knights and the Hen and Chickens. Fossil examples from limestone cave deposits near Hikurangi are typical *busbyi*, so the far northern *watti* must have diverged through long isolation along with other distinctive elements of the Aupourian land fauna, that is, *Placostylus ambagiosus, priscus, consobrinus* and *annectens* as well as *Rhytida duplicata* and *duplicata vivens* n. subsp.

The species is named in recognition of assistance in the field, given, during three visits to the extreme north, by my esteemed friend Mr. A. H. Watt of Paua, Parengarenga.

## Subgenus **POWELLIPHANTA** O'Connor, 1945.

Type (o.d.): HELIX HOCHSTETTERI Pfeiffer.

This subgenus contains all the remaining New Zealand members apart from the two species of the typical subgenus, *busbyi* and *watti*. The composition of the shell differs from that of the typical subgenus in being mostly conchin. They are variously radially striped or spirally banded, and the egg has a thin limy shell, always with a transparent cuticle.

Some species, notably *spedeni* and *rossiana*, are so lacking in lime that they quickly collapse when vacated by the animal, but the shells can be softened and the shape restored by a technique (see O'Connor, 1945, p. 56) which involves relaxing the shells by placing them in very hot water. Only in exceptional instances does the shell long survive

death of the animal. Subfossil examples of *Powelliphanta* are known only from limestone caves (near Te Kuiti, and Punipaua, West Nelson), where replacement of the conchin by lime has occurred.

The subgenus may be divided into well marked series each of which has a definite area of distribution: They are:—

A, the *rossiana* series, which commences near East Dome, Southland, and terminates so far as is known with *gagei* from Rewanui, Greymouth, and Kirwan's Hill, north-east of Reefton. These are all of small size, very thin and composed almost entirely of conchin. They are dark greenish to dark brown with black axial streaks as the only colour pattern. The radula in *rossiana, gagei* and *fletcheri* is so similar in formula and in detail to that of the larger typical species that subgeneric separation is not warranted.‡

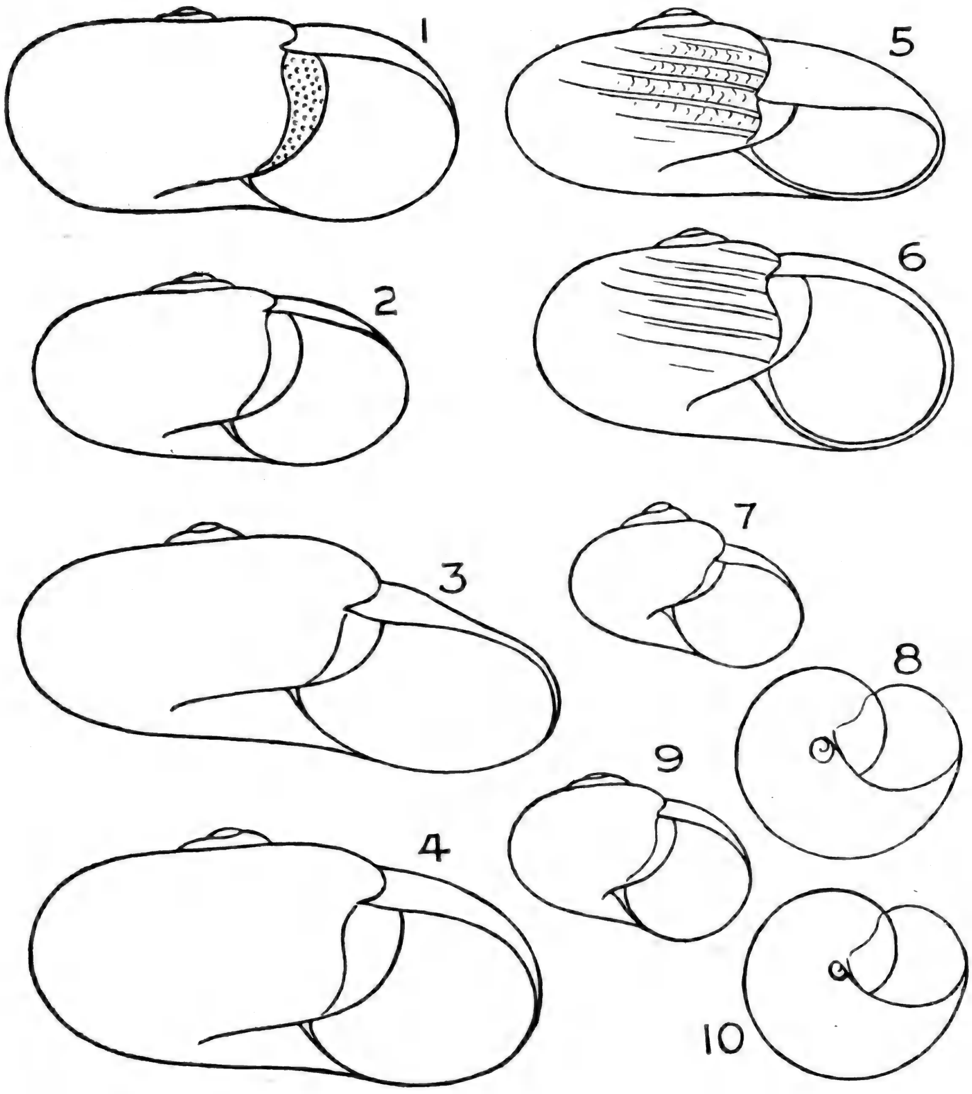
B, the *lignaria* series commence near Westport and extend northward to West Nelson and the western slopes of the Mount Arthur Tableland. The dominant feature of the *lignaria* series is radial colour banding, but it tends to plain ground colour both at the commencement with *unicolorata* and at its termination in the *superba* group, the largest members of the genus. Several members of the *lignaria* series show granulation of the parietal callus, a feature which comes in north of Karamea and is last seen in this group in two subspecies of *superba* from the Heaphy end of the Gouland Downs area. The *lignaria* series have the deep body-whorl and there seems little doubt that both the *hochstetteri* and the *gilliesi* series had their origin respectively from *lignaria* stock in West Nelson.

C, the *gilliesi* series are characteristic of the Wakamarama Range and the mountains of the eastern side of the Aorere Valley, West Nelson. They must have arisen by mutation from the *lignaria* stock. They are small and have a shallow body-whorl, but are the only group other than *lignaria* to possess the granulated callus. Also the Gouland Downs *jamesoni,* although having a smooth callus and spiral lines on the dorsal surface still preserves the *lignaria* radial streaks on the base.

D, the *hochstetteri* series are large, spirally banded and zoned, and with the deep body-whorl, as in *superba.* They occur on the Tasman-Pikikiruna Ranges of Nelson, the mountains of Marlborough and on the Ruahine Range of the North Island. The link with *superba* of the *lignaria* series is gauged from the fact that *superba* shows vestigal radials in its juvenile stage and an occasional incipient spiral in its adult stage.

E, the *traversi* series belongs to the coastal plain north of Wellington and west of the Tararua Range. It is suggested elsewhere in this paper that the *traversi* series arose by mutation from *obscura-bicolor* stock of the *hochstetteri* series. The *traversi* series are of smaller size and have the shallow body-whorl, but does not possess the granulated callus of the *gilliesi* series.

‡Dental formulae:—*P. busbyi,* 50 + 0 + 50; *hochstetteri,* 67 + 1 + 67; *h. bicolor,* 67 + 1 + 67; *superba,* 66 + 1 +66; *lignaria,* 70 + 1 + 70; *unicolorata,* 54 + 1 + 54; *gilliesi,* 59 + 1 + 59; *g. subfusca,* 64 + 1 + 64; *traversi,* 65 + 1 + 65; *rossiana,* 69 + 1 + 69; *gagei,* 59 + 0 + 59; *fletcheri,* 66 + 1 + 66.




**Text Fig. A.**

1. *Paryphanta (Powelliphanta) superba harveyi* Powell, n. subsp.
2. *Paryphanta (Powelliphanta) superba mouatae* Powell, 1936.
3. *Paryphanta (Powelliphanta) superba richardsoni* Powell, n. subsp.
4. *Paryphanta (Powelliphanta) superba superba* Powell, 1930.
5. *Paryphanta (Paryphanta) watti* Powell, n. sp.
6. *Paryphanta (Paryphanta) busbyi* (Gray, 1940).

7-8. *Paryphanta (Powelliphanta) spedeni lateumbilicata* Powell, n. subsp.

9-10. *Paryphanta (Powelliphanta) spedeni* Powell, 1932.

(All figures to uniform scale of 4/5)

## A. THE ROSSIANA SERIES.

### **Paryphanta spedeni** Powell, 1932. Text figs. A9-10.

1932 *Paryphanta spedeni* Powell, Rec. Auck. Inst. Mus. Vol. 1, No. 3, p. 159, Pl. 28, figs. 3, 4, and 5.

*Locality:* West side of Mataura River, opposite East Dome, on range at about 3,200 feet, Southland (corrected type locality, see Powell, 1938, Rec. Auck. Inst. Mus., Vol. 2, No. 3, p. 137).

### **Paryphanta spedeni lateumbilicata** n. subsp. Text figs. A7-8.

In my 1938 paper (l.c.) I extended the range of *spedeni* by recording a new locality, Billow Mountains, near Lake Monowai, but now, after again examining the small series of five specimens, three of which are in the collection of Mr. A. C. O'Connor, I am convinced that a new subspecies is represented by the Monowai occurrences. The Monowai shells have a less globular body-whorl, more exserted spire, wider umbilicus, weaker spiral striae and are darker, especially on the base, while the dorsal surface lacks the characteristic bronze sheen of *spedeni* typical. The dorsal colour in both *spedeni* and *lateumbilicata* is very dark greenish brown, but the former has a diffused argus-brown tinge and in the latter the tone is nearer to raw-umber. The ventral surface is between olive-brown and dark-olive in *spedeni* typical, with irregular axial streaks of very dark green, almost black. In *lateumbilicata* the base is so much darker that the axial streaks are scarcely apparent.

The following table indicates the relative size of the umbilicus in species and subspecies.

| *spedeni spedeni.* | | *spedeni lateumbilicata.* | |
|---|---|---|---|
| Major diameter. | Width of umilicus. | Major diameter. | Width of umbilicus. |
| 31 mm. | 3.00 mm. | 30.5 mm. | 3.75 mm. |
| 36 mm. | 3.50 mm. | 32.5 mm. | 4.00 mm. |
| 39 m.m. | 3.75 mm. | | |

**Table of dimensions for spedeni and s. lateumbilicata.**

| Major diameter: | Minimum diameter: | Height: | Depth of body-whorl: |
|---|---|---|---|
| *spedeni spedeni* | | | |
| 39.0 m.m. | 30.0 mm. | 25.0 mm. | 16.0 mm. |
| 35.8 mm. | 28.4 mm. | 23.5 mm. | 14.0 mm. |
| 33.0 mm. | 26.25 mm. | 23.0 mm. | 13.5 mm. |
| 28.0 mm. | 23.00 mm. | 20.5 mm. | 13.0 mm. |
| *spedeni lateumbilicata* | | | |
| 35.8 mm. | 28.0 mm. | 24.0 mm. | 13.2 mm. |
| 33.0 mm. | 26.5 mm. | 22.5 mm. | 12.75 mm. |
| 32.0 mm. | 26.0 mm. | 21.5 mm. | 12.5 mm. (holotype) |
| 29.5 mm. | 24.5 mm. | 20.5 mm. | 12.2 mm. |

*Localities:* Billow Mountains at 3,000 feet near South West shore of Lake Monowai, Otago (type collected by Mr. S. W. Mayo, December, 1937); Mount Hindley at 3,500 feet (collected by Mr. A. Clark, 1938) per Mr. A. C. O'Connor.

*Holotype:* Powell collection, Auckland Museum.

## B. THE LIGNARIA SERIES.

In the collection of Mr. Arthur Richardson of Papakura there is a *"lignaria"* from Larrakin's Creek, a tributary of the South Branch of the Mokihinui River, draining the high watershed between the Mokihinui and Matiri Rivers (collected by E. De Malmanche, 1938).

If this specimen came from the upper reaches of the creek it would be approximately topotypic of Hutton's original *lignaria* which was from a "saddle between Mokihinui and Lyell Rivers."

Unfortunately Hutton's type is not in the Canterbury Museum as stated by Suter (1913, Man. N.Z. Moll., p. 783), but was returned by Hutton to its discoverer, Dr. Gaze, Westport (Suter l.c. Errata p. XIV). The original description reads—"irregularly banded in the direction of the growth lines with dark reddish-brown and pale brownish-yellow-upper surface finely irregularly granulated by deeply undulating impressed lines—." In 1900 Hutton figured an example without colour bands from Mt. Rochfort near Westport and erroneously ascribed it to his original *lignaria* of 1888. This is the uniformly light coloured form which I described in 1930 as *P. unicolorata*, type from the flat at Seddonville.

Just across the Mokihinui River from Seddonville and extending northwards to Karamea there occurs the alternately light and dark axially banded form which I ascribed to Hutton's original *lignaria* (Powell 1930, Rec. Auck. Inst. Mus. Vol. 1, No. 1, p. 42, Pl. 4, f.1.). Later, (Powell 1941, l.c. Vol. 2, No. 5, p. 239) I nominated at St Helens, Mokihinui specimen as neotype, since the original holotype is presumed lost. It is possible that an unlabelled specimen from the collection of the late Mr. Boswell of Westport, and now in the Auckland Museum, is Hutton's missing holotype. It has the base missing as mentioned by Hutton, but the dimensions are slightly greater. If this is the type then my 1930 interpretation of *lignaria* is correct.

On the other hand the sparsely striped *lignaria oconnori* Powell 1938 (Rec. Auck. Inst. Mus. Vol. 2, No. 3, p. 134), which comes from the headwaters of the Leslie River, 2,000 feet, western slopes of the Mount Arthur Tableland, is very close to, but not identical in coloration with, the Larrakin's Creek shell, which by its location should be nearer to the original *lignaria* than my St. Helens neotype.

The position cannot be finalised until topotypes of Hutton's species are obtained, but the indications are that *oconnori* will stand as a northern subspecific form and that the Mokihinui-Karamea coastal form will require to be named, my nomination of a St. Helens specimen as neotype becoming void.

### Key to Unicolorata Subspecies.

Dorsal surface plain or with narrow light brown spiral lines.
Ventral surface plain ........................ *unicolorata unicolorata* Powell
Dorsal surface with dense dark reddish-brown spiral lines.
Ventral surface with dense light-brown narrow spiral lines.
........................................ *unicolorata rotella* Powell
Ventral surface with spiral bands and lines of deep reddish-brown ..........
........................................ *unicolorata johnstoni* n. subsp.

### Paryphanta unicolorata Powell, 1930.

1930—*Paryphanta unicolorato* Powell, Rec. Auck. Inst. Mus. Vol. 1, No. 1, p. 43, Pl. 4, f. 2 and Pl. 6, f. 6.

Typical *unicolorata* has an almost uniform ground colour of between ecru-olive and Isabella colour (Ridgway). A large series from the Seddonville flat (around the type locality), collected by Mr. A. C. O'Connor, shows the species to be constant except for occasional variants with fine dense light-brown spiral lines on the dorsal surface and about 5% with irregularly disposed narrow dark-brown axial streaks, as in *rotella*. Typical *unicolorata* occupies the Seddonville flat and extends to the east of Chasm Creek, which feature Mr. W. H. Johnston has found to form the boundary between *unicolorata* and a new subspecies which occupies the area to the west of Chasm Creek.

The distributional area of *unicolorata* is limited to the north by the Mokihinui River and to the west and south by the encircling sweep of Chasm Creek. The eastern extension of the species remains to be determined.

*Localities:* Seddonville, West Coast, Nelson, from around flax bushes *(Phormium)* (C. L. Wragge, 1908) (type); Seddonville flat, under logs and clumps of blackberry on partially cleared land (A. C. O'Connor, 5:11:1940); East, or Seddonville side of Chasm Creek, near confluence of Chasm Creek and Mokihinui River (W. H. Johnston, 1945).

### Paryphanta unicolorata rotella Powell, 1938.

1938—*Paryphanta unicolorata rotella* Powell, Rec. Auck. Inst. Mus. Vol. 2, No. 3, p. 137, Pl. 33, figs. 8 and 9.

The presence of radial streaks in typical *unicolorata* as well as in *rotella* does not reduce true *rotella* to a synonym since that subspecies was based primarily upon the dense pattern of dark red-brown spirals on the dorsal surface and subobsolete light-brown spirals on the base. The distribution of *rotella* is high country along the radial spurs running westward from Mt. Glasgow. The type locality is 1,200 feet, between the headwaters of the St. Andrews and St. George's Streams and it is recorded again from the same area at 1,800-2,000 feet. A third occurrence is on the ridge, 400-500 feet near the old State Mine. Thus the high country *rotella* form invades the higher country of the area of *unicolorata*-typical by coming down a leading spur from Mt. Glasgow and entering at the eastern end of the *unicolorata*-typical area, where no barrier exists.

*Localities:* Between headwaters of St. Andrew's and St. George's Streams, tributaries of the Ngakawau River, at 1,200 feet, Western slopes of Mt. Glasgow, West Nelson (type); vicinity of headwaters of St. Andrew's Stream at 1,800-2,000 feet; ridge between Coal Creek and Chasm Creek at 700 feet; East side of Chasm Creek, 400-500 feet near old State Mine (W. H. Johnston).

### Paryphanta unicolorata johnstoni n. subsp. Pl. 9, figs. 3 and 4.

Dorsal surface prominently spirally banded and lined in dark reddish-brown, upon a diffused, mostly light reddish-brown ground colour. There is a subsutural band of yellowish-olive and the ground colour of

the early whorls is more olive than reddish. There are five spiral colour lines on the early whorls and from ten to twelve lines and bands on the dorsal surface of the body-whorl. The ventral surface is conspicuously spirally banded and lined with chestnut on a yellowish olive or Isabella-coloured (Ridgway) ground. The inner third of the base is free from colour lines. The basal colour and pattern resembles that of *hochstetteri*. There are from 15 to 17 spiral colour bands and lines on the base. These bands are distant and irregularly spaced with groups of two to five closely-spaced lines between them.

Major diameter 45.5 mm.; minimum diameter 37 mm.; height 25 mm. (holotype)
Major diameter 40.0 mm.; minimum diameter 34 mm.; height 23.8 mm.

*Locality:* West side of Chasm Creek towards junction with the Mokihinui River at 100-500 feet (W. H. Johnston, 1945).

*Holotype:* Auckland Museum.

This subspecies is likely to occur along the coastal range to about six miles south of the type locality. It is a rectangular area bounded by the Mokihinui River to the north, the sea to the west, the Ngakawau River to the south, and Charming Creek and Chasm Creek to the east. Charming Creek flows south to the Ngakawau and Chasm Creek bears northward to the Mokihinui. Chasm Creek affords a clear-cut separation between *johnstoni* and the other two forms of *unicolorata,* typical and *rotella.* Similarly the Mokihinui River is the barrier between the *unicolorata* series and *"lignaria,"* the latter commencing almost immediately, on the north side of the river.

The status of the shells from Mt. Rochfort near Westport, which were wrongly ascribed by Hutton (1900, Trans. N.Z. Inst. 32, p. 22, Pl. 2) to his *lignaria* of 1888, still remain to be satisfactorily placed. They may be either *rotella* or still another subspecies.

**Key to Superba Subspecies.**

Body-whorl deep, compared with maximum diameter.
  Shell very large (up to 90 mm.)
    Colour uniformly yellowish to old-gold.
      Parietal callus smooth .................... *superba superba* Powell.
      Parietal callus granular ................. *superba prouseorum* n. subsp.
  Shell smaller (up to 63 mm.)
    Colour cinnamon-brown.
      Parietal callus smooth .................... *superba mouatae* Powell
    Colour light brown axially banded with reddish brown.
      Parietal callus granular ................... *superba harveyi* n. subsp.
Body-whorl shallow, compared with maximum diameter.
  Shell of medium size (up to 76 mm.)
    Colour orange-citrine (darker than *superba typical*)
      Parietal callus smooth ................ *superba richardsoni* n. subsp.

## Paryphanta superba Powell, 1930. Text fig. A4.

1930. *Paryphanta superba* Powell, Rec. Auck. Inst. Mus. Vol. 1, No. 1, p. 41. Pl. 4, f. 3 (not Pl. 3).

The type locality for this species is Cedar Creek Ridge at about 2,500 feet, between the Boulder and Clark Rivers on the eastern side of the Aorere Valley, West Nelson.

At the time of description of the species I included in its range two specimens from five miles south of Rocks Point and North of Karamea Bight. These were figured (Powell 1930, Pl. 3) from an excellent photograph by Mr. Wm. C. Davies of the Cawthron Institute, Nelson, but I did not handle the actual specimens, which now prove to be subspecifically separable. Recently I examined about a hundred examples collected by Messrs. H. S. and R. A. Prouse from between Rocks Point and Kahurangi Point. These show a constant difference from typical *superba* in the form of the parietal callus, which is granulate, that of *superba* typical being constantly smooth. All the records of *superba* were then checked and it was found that the Wakamarama Range shells were true *superba*, although on the opposite side of the Aorere Valley to the type locality. The Gouland Downs provides high country continuity between the Eastern Aorere Mountain systems and the Wakamarama Range, but so far no colonies of true *superba* have been located in the Gouland Downs area, but in place of it there are at least three subspecific forms, each apparently occupying its own restricted area. One of these is the form which I described as *Paryphanta mouatae* (Powell, 1936, p. 31) from between 15 Mile Creek and Saxon Creek. The other subspecific forms are dealt with, following. If typical *superba* formerly ranged across the Gouland Downs area it may yet remain isolated on high areas such as Downs, 3,650 feet, Hawke's Knob, 2,755 feet, and Mt. Perry, 3,993 feet.

*Localities* (*superba* typical): Cedar Creek Ridge, 2,500 ft. eastern side of Aorere Valley (type); Bock Peak, 3,200 ft. near Mt. Stevens, Wakamarama Range, west of Bainham; and Knuckle Hill, 1,661 ft., between the head waters of the Kaituna River and West Haven Inlet.

### **Paryphanta superba prouseorum,** n. subsp.

1930. *Paryphanta superba* Powell, Rec. Auck. Inst. Mus. Vol. 1, No. 1 (in part) Pl. 3 only.

Shell very large, the maximum so far known for the genus. It is identical in shape and ground colour (sulphine-yellow to old-gold of Ridgway) with *superba* typical, but differs constantly in having the parietal callus finely granulated instead of being smooth. There is a tendency also, especially in young shells, to develop irregular axial diffused bands of reddish-brown and on the base an occasional spiral of pale olive-brown. The parietal callus in young shells is purplish-grey and becomes chocolate only when fully adult. In *superba* typical the callus is dark chocolate at all stages of growth. The granulations are particularly noticeable in young examples of the subspecies, but are entirely absent at all growth stages from the typical species.

The dimensions are given in a comparative table following the descriptions of all of the *superba* subspecies.

*Localities:* Between Kahurangi Point and Rocks Point, 2 to 3 miles inland at 1,500-2,000 feet, collected by Messrs. H. S. and R. A. Prouse (type); 5 miles south of Rocks Point, north of Karamea Bight and 1 mile inland at 1,000 feet, collected by Mr. Wastney of Nelson.

The subspecies is named in recognition of the excellent field work of both Messrs H. S. and R. A. Prouse.

**Paryphanta superba richardsoni** n. subsp. Text fig. A3.

This is a depressed *superba* of darker colour and with a smooth parietal callus. The ground colour is orange-citrine (Ridgway) with diffused very pale reddish-brown axial streaks, and the rest stages marked by narrow olive-coloured axial lines; parietal callus chocolate. The depressed shape is caused by the much reduced depth of the body-whorl compared with typical *superba, superba prouseorum, superba mouatae* and *superba harveyi.* The measurement for body-whorl depth is taken vertically in front of the shell and extends from the suture to the greatest basal convexity before incurving to the umbilicus. This is the final column of dimensions in the table following.

*Localities:* Perry's Pass, two miles from Blue Duck Creek Hut, Gouland Downs, West Nelson (type), collected by Mr. A. C. O'Connor 3:11:1939 and Mr. A. Richardson.

*Holotype:* Auckland Museum.

**Paryphanta superba mouatae** Powell, 1936. Text fig. A2.

1936. *Paryphanta mouatae* Powell, Rec. Auck. Inst. Mus. Vol. 2, No. 1, p. 31, Pl. 8, figs. 7 and 8.

After seeing extensive series of this subspecies collected by Mr. A. C. O'Connor, it became evident that two subspecies were covered in my original description, a small almost uniformly dark form with a convex top and a smooth parietal callus, which is typical *mouatae,* and an alternately yellowish-brown and reddish-brown axially banded form, with a flat top and a granulated parietal callus, which is described, following, as *superba harveyi* n. subsp.

Shell of *mouatae* much smaller than *superba* typical and much darker. The top is low, slightly convex and scarcely sunken at the suture. The outline of the body-whorl is evenly arcuate from the suture to the umbilicus. The ground colour is cinnamon-brown fading to dresden-brown around the umbilicus and is irregularly axially streaked with mars-brown and an occasional growth mark of olive-brown (Ridgway). The parietal callus approximates to mars-brown and is quite smooth.

*Localities:* Gouland Downs, West Nelson, between 15 Mile Creek and Saxon Creek (collected by Mr. A. Harvey and obtained per Mrs. M. Mouat (holotype); Headwaters of Saxon Creek, 3½ miles from Blue Duck Creek Hut (collected by Mr. A. C. O'Connor, 1:11:1939).

**Paryphanta superba harveyi** n. subsp. Pl. 9, figs. 5 and 6. Text fig. A1.

1936. *Paryphanta mouatae* Powell, Rec. Auck. Inst. Mus. Vol. 2, No. 1, p. 31 (in part, reference to parietal granulations).

This is the handsome axially banded form to which I originally intended the name *mouatae* to apply. Only dead shells of the banded form were available at the time of description, and by the selection of a small almost uniformly coloured example as holotype *mouatae* was fixed as described above, but now leaves the banded form with the granular callus available to bear the name of the original collector, Mr. A. Harvey, of Collingwood.

Shell differing from *superba mouatae* in being almost flat on top with the sutural area sunken and the crest of the body-whorl higher than the suture, forming in profile a high subangle to the outline of the body-whorl, when viewed from the front. There is a second subangle towards the umbilicus. The connecting curve between the two subangles is obliquely broadly arcuate. Ground colour buckthorn brown axially banded with broad zones of Hay's russet. Parietal callus Hay's brown (Ridgway) or possibly darker in fresh specimens, sparsely but distinctly granulated.

*Locality:* Gouland Downs—Heaphy Track, probably in Buller County near to the Buller Boundary. Collected by Mr. A. Harvey.

Unfortunately some of Mr. Harvey's numbered localities became detached from the specimens he gave Mrs. Mouat, but by elimination it is almost certain that the above locality applies to the shells here described. All the Harvey material came from the Gouland Downs—Heaphy track—and the presence of parietal granules in *harveyi* would suggest that the type locality was from the Heaphy end, especially since both *annectens* and *superba prouseorum* have the granular callus. This feature disappears in the north-eastward succession of subspecies, i.e., *superba mouatae, superba richardsoni* and *superba superba*; in that order.

*Holotype:* Auckland Museum. The writer is indebted to both Mr. A. C. O'Connor and Mrs. M. Mouat for the type material of this subspecies.

**Table of dimensions for superba and subspecies:**

| Major diameter: | Minimum diameter: | Height: | Depth of body-whorl* | |
|---|---|---|---|---|
| *superba* | | | | |
| 80.0 mm. | 67.0 mm. | 40.0 mm. | | |
| 77.0 mm. | 65.0 mm. | 38.0 mm. | | (holotype) |
| 76.5 mm. | 64.5 mm. | 39.0 mm. | 28.0 mm. | |
| 70.0 mm. | 59.5 mm. | 39.5 mm. | 24.75 mm. | |
| 61.5 mm. | 55.0 mm. | 33.0 mm. | 25.0 mm. | |
| 56.0 mm. | 47.0 mm. | 32.0 mm. | 23.5 mm. | |
| *superba prouseorum* | | | | |
| 90.0 mm. | 74.0 mm. | 38.0 mm. | | (H.S.Prouse |
| 89.0 mm. | 75.0 mm. | 42.5 mm. | 30 mm. | coll.) |
| 81.0 mm. | 68 0 mm. | 39.0 mm. | 28.5 mm. | |
| 79.0 mm. | 65.5 mm. | 38.0 mm. | 30 mm. | (holotype) |
| 71.0 mm. | 61.0 mm. | 36.5 mm. | 25.5 mm. | |
| 50.0 mm. | 41.5 mm. | 30.5 mm. | 22.0 mm. | |
| *superba richardsoni* | | | | |
| 76.0 mm. | 63.0 mm. | 36.0 mm. | 25.1 mm. | (holotype) |
| 73.5 mm. | 60.5 mm. | 35.5 mm. | 23.75 mm. | |
| 72.0 mm. | 58.0 mm. | 36.0 mm. | 24.5 mm. | |
| 69.5 mm. | 56.0 mm. | 33.0 mm. | 23.0 mm. | |
| 60.0 mm. | 49.0 mm. | 28.0 mm. | 22.0 mm. | |
| 60 0 mm. | 50.0 mm. | 29.0 mm. | 23.0 mm. | |
| 59.5 mm. | 49.0 mm. | 29.5 mm. | 22.5 mm. | |
| *superba mouatae* | | | | |
| 61.5 mm. | 52.5 mm. | 36.0 mm. | 25.5 mm. | |
| 57.0 mm. | 47.5 mm. | 30.0 mm. | 23.0 mm. | |
| 51.0 mm. | 42 5 mm. | 28.5 mm. | 22.0 mm. | |
| 50.0 mm. | 42.5 mm. | 27.0 mm. | 22.1 mm. | (holotype) |
| *superba harveyi* | | | | |
| 64.00 mm. | 54.0 mm. | 31.0 mm. | 25.0 mm. | (holotype) |
| 62.75 mm. | 51.0 mm. | 29.5 mm. | 25.0 mm. | |
| 60.0 mm. | 51.0 mm. | 30.5 mm. | 24.5 mm. | |
| 47.5 mm. | 41.0 mm. | 28.0 mm. | 22.0 mm. | |

## C. THE GILLIESI SERIES.

### Paryphanta gilliesi (Smith, 1880).

1880. *Paryphanta gilliesi* Smith, Ann. Mag. Nat. Hist. Ser. 5. Vol. 6, p. 159.
1930. *Paryphanta gilliesi* Powell, Rec. Auck. Inst. Mus. Vol. 1, Pt. 1, p. 44.

Smith's type is a collapsed shell in the British Museum from "Whakamarara Mountain, Collingwood." In my 1930 paper this was interpreted as Mt. Burnett, Collingwood, near the northern extremity of the Wakamarama Range. My material, from which I selected a neotype (Auckland Museum collection), was taken from between 1900 and 2000 feet. The Prouse cousins have now found the species to be common below the coal shaft at 600-700 feet, and they obtained several juveniles at 100-150 feet, but there are no records of these snails either from the coastal strip between Collingwood and Cape Farewell or the area flanking the road between Pakawau and West Haven Inlet. The nearest approach to *gilliesi* typical from elsewhere is from the Wakamarama Range, three miles south of Mt. Burnett and north of the Kaituna River (collected by Mrs. M. Mouat).

In *gilliesi* typical the base is bright red-brown, like rosewood, with a large, sharply defined, dark red-brown, almost black area surrounding the umbilicus. The top is umber shading to burnt-sienna and the dark brown spiral bands and lines are mostly rather distantly spaced.

### Paryphanta gilliesi subfusca Powell, 1930.

1930. *Paryphanta gilliesi subfusca* Powell, Rec. Auck. Inst. Mus. Vol. 1, pt. 1, p. 47.

The type locality is Kaihoka, between the two lakes, in a small area of coastal forest containing "ponga" tree ferns and "nikau" palms, elevation 120 feet. The locality is isolated from the Wakamarama Range by the northern arm of West Haven Inlet.

In *subfusca* typical the base is olive-brown gradually deepening to dark greenish to reddish-brown around the umbilicus. The top is greenish-umber shading to sienna-brown and the dark-brown spirals are more numerous and of more even development with less of the ground colour showing than in *gilliesi* typical. A constant feature is the more rounded and compact peripheral outline, when viewed from above. In *gilliesi* typical the last $\frac{1}{4}$ whorl accelerates.

Four other localities for *subfusca*, investigated by the Prouse cousins, reveals the presence of two colour forms, one with a basal colour of dull reddish-brown and the other deep red-brown as in *gilliesi* typical. The nearest match to *subfusca* is from Oyster Point, $1\frac{1}{2}$ miles south of the type locality, on the north shore of West Haven Inlet, in small gullies containing coastal scrub, at 100-120 feet. These have the olive-brown base slightly diffused with reddish-brown, but are otherwise identical with those of the type locality.

*Form A.* This is a small colony found in dense manuka scrub at 150 feet on the south-west side of Green Hill Creek about two miles south-west of Wharariki, which is near Cape Farewell. The colony is characterized by rather stunted growth, and they have the base dull

reddish-brown, rood's-brown to burnt-sienna without the dark greenish factor. The top is burnt-sienna to dull reddish-brown and bears closely spaced, narrow, dark-brown spiral lines. In shape they lack acceleration as in typical *subfusca.*

*Form B.* This form occurs at Travers' Bush, 50 feet, separated from the Kaihoka locality by only twenty chains of clearing, but at a considerably lower elevation. An almost identical colony occurs at White Pine Creek, 20-25 feet, on the opposite shore of the northern arm of West Haven Inlet, almost due south of the Oyster Point locality. They occur under "toitoi," fern and rushes, in coastal scrub. These two colonies have the compact outline and closely spirally lined top of *subfusca,* but the zoned base of *gilliesi* typical. They are deep red-brown both above and below.

The whole of the West Haven area requires to be worked thoroughly before the distributional area for this form B can be satisfactorily determined; meanwhile it is left unnamed. Both the Travers' Bush and the White Pine Creek localities are probably remnants of a former widespread low level dispersal of this "red-*subfusca*" along the western drainage of the northern section of the Wakamarama Range.

From study of geological maps of the area (N.Z. Geol. Surv. Bull. No. 25) it would appear that *subfusca* typical is more or less restricted to the Miocene limestone coastal area and *gilliesi* typical to the older Tertiary Pakawau Series.

The Travers' Bush colony could be explained as an incursion into the limestone area from the older Tertiary area, for its location is near sea level at the head of the northern arm of the Inlet where no water barrier exists at present. On the other hand there may have been a water barrier between Travers' Bush and Kaihoka Lakes at a former period, for there is evidence of captured drainage, that is, if we assume a progressive extension of the northern arm of West Haven Inlet.

Another possibility remains to be investigated. How are the factors governing coloration affected when species are segregated into small colonies (see under *traversi* series)?

### **Paryphanta gilliesi aurea** n. subsp. Pl. 10, figs. 7 and 8.

This subspecies stands out from all others of the *gilliesi* series by its golden to olive basal ground colour and olive-brown dorsal surface. Reddish-brown, so characteristic of the other *gilliesi* forms, occurs in *aurea* normally, only as a diffused umbilical patch. In Ridgway's terminology the base is of old-gold ground colour overlaid with dense but inconspicuous narrow radial streaks of buffy-citrine. The diffused umbilical patch is mahogany-red to chestnut. The callus, which is strongly and densely granulated, approximates to dark indian-red. In contrast to the glossy ventral surface the dorsal area is rendered dull by dense microscopic wavy striations and is patterned with numerous strong spirals of dark-chestnut and subsidiary dark green lines. At the periphery there are two or three broad spiral bands of dark brown, the lower one frequently breaking down into several irregular dark

green lines. The base of the holotype exhibits faint narrow spiral brownish lines. Some paratypes have a conspicuous dark green basal line at about one-third the diameter in from the periphery. A few show a general diffusion of the reddish-brown umbilical area over the ventral surface, so that the base closely resembles that of *brunnea*, but such examples retain the characteristic olive-brown dorsal colour. The dorsal coloration is the most constant difference between *aurea* and *brunnea*. In *brunnea* both the dorsal and ventral surfaces are orange-brown, antique-brown to amber-brown.

Both *aurea* and *brunnea* occupy, respectively, two isolated small remnants of the original forest cover, one at low altitude, 20-30 feet, the other at 600 feet, and separated by only $2\frac{1}{4}$ miles in direct line. Together these subspecies differ from all known forms of *gilliesi* in having the base almost devoid of definite colour zones and bands.

The species *compta*, from the opposite side of the Aorere Valley to the Wakamarama-West Haven *gilliesi* series, resembles *aurea* in ground colour and in the presence of occasional narrow green spirals as well as a diffused reddish-brown umbilical area. However, the umbilicus of *compta* is much narrower and the parietal callus is dark pinkish-grey with only a few scattered minute granulations.

| Major diameter: | Minimum diameter: | height: |
|---|---|---|
| 50.5 mm. | 43.0 mm. | 28 mm. (holotype) |
| 48.5 mm. | 42.0 mm. | 30 mm. |
| 48 mm. | 42.0 mm. | 26.5 mm. |
| 47 mm. | 42.0 mm. | 30.75 mm. |

*Locality:* Mangarakau, 600 feet, north of Paturau River, West Nelson, in a small area of coastal forest on the property of Mr. H. S. Prouse (see N.Z. Geol. Surv. Map, Onetaua, Pakawau and Paturau Survey Districts, Bull. No. 25). The locality for *brunnea* is on the north side of the Paturau, near the mouth at 20-30 feet.

*Holotype:* Auckland Museum.

Large series of both *aurea* and *brunnea* from the collections of Messrs. H. S. and R. A. Prouse, Mr. A. C. O'Connor, and examples presented to the Auckland Museum by the former, have been studied.

Both *aurea* and *brunnea* are restricted to small areas and their survival is uncertain.

### Paryphanta jamesoni Powell, 1936.

1936. *Paryphanta jamesoni* Powell, Rec. Auck. Inst. Mus. Vol. 2, No. 1, p. 35.

*Localities:* Blue Duck Creek, near hut at about 2,069 feet (type); Saxon Creek, Gouland Downs, West Nelson.

At least three recognisable forms of this species occur along the Gouland Downs track from the vicinity of Blue Duck Creek and Saxon Creek to the Collingwood boundary. Collingwood Boundary examples can be readily distinguished from those of Blue Duck Creek, the type locality, by their more reddish-brown colour, strong spiral banding of the top and peripheral area and obsolescence of the basal dark axial streaks. A third form from near Saxon Creek has dense narrow spirals

on the dorsal surface as in *fallax,* but the base is bright reddish-brown with strong subperipheral broad black spiral bands, reminiscent of *gilliesi.*

All the collections so far made have been from the two abovementioned localities, which are about nine miles apart. Further collecting, especially from intermediate localities, is essential before these forms of *jamesoni* can be satisfactorily evaluated.

## E. THE TRAVERSI SERIES.

Owing to the fact that the once almost continuous lowland forest of the Horowhenua area has been destroyed to a very large extent for agricultural purposes, accurate reconstruction of the former distributional areas for *traversi,* its subspecies and forms, is now a difficult matter.

Except for a few occurrences on the foothills to the Tararua Range, at Kaihinu and Shannon Heights, these snails do not appear to have an extensive high country range. They were most strongly represented on the low country of the coastal plain, but today they survive only in a few of the small forest reserves scattered along the plain from Koputaroa, four miles north-east of Levin, to Te Horo, about 16 miles south-west of Levin.

From enquiries made by the Prouse cousins it is assumed that the large scale clearing of land for agricultural purposes in the Levin area was between 1890 and 1900. For the Shannon district earlier settlement is indicated.

The points to be considered are:—

(1) Do the existing colonies suggest that there was natural segregation of forms in pre-European times?

(2) Do the differences observed in colonies isolated at the present time suggest that such colonies are individually producing forms that are evolving along different lines due to this artificially induced isolation factor?

(3) Does change in the nature of the forest cover, that is, the deterioration from virgin forest to scrub and fern, exert an influence in the production of new forms?

(4) Are the diverse tendencies observed in certain small colonies a problem in genetics?

From study of long series, collected by the Prouse cousins, Mr. A. C. O'Connor and the writer, from a number of localities, isolated under present conditions, some more or less reasonable conclusions, together with some conjectures, are now given. As a preliminary to this discussion the following table sets out the main observable factors in the *traversi* series.

### TABLE OF FACTORS IN THE FORMS OF TRAVERSI.

Dorsal Surface:—

A. PLAIN TOP—Isabella colour (light yellowish brown), tinged with citrine—occasional weak spirals encroaching from peripheral area.

B. REDDISH-BROWN TOP—Olive-lake to Dresden-brown, diffused and partially to completely spirally lined with Mars-brown, but no broad bands.

C. HALF SPIRALLED TOP—Yellowish-citrine to buffy citrine with a few brown bands and lines mostly on outer half of whorls.

D. COMPLETE SPIRALLED TOP—More or less completely spirally lined and banded with light to dark reddish-brown.

E. COMPLETE SPIRALLED TOP + REDDISH-BROWN — Same as D, but diffused with reddish-brown.

F. COMPLETE WAVY-SPIRALLED TOP—Olive-lake, with more or less uniform pattern of closely spaced wavy lines and bands of dark reddish-brown and occasional axial streaks of same colour.

G. COMPLETE WAVY-SPIRALLED TOP + REDDISH-BROWN — Same as F, but diffused with dark reddish-brown.

Ventral Surface:—

H. PALE YELLOWISH BASE—Yellowish-citrine with indistinct light-brown spiral lines and a central area of Mars-brown.

I. GREENISH BASE—Greenish-olive with faint to moderate dark narrow spiral lines of olive and Roman-green and a central diffused patch of Mars-brown.

J. NARROW SPIRALLED BASE—Numerous narrow brown spirals on old-gold ground with central area of diffused cinnamon-brown to Mars-brown.

K. NARROW SPIRALLED DIFFUSED BROWN BASE—Very numerous narrow spirals generally diffused with reddish-brown.

L. HEAVY SPIRALLED BASE—A fairly open pattern of dark-brown spiral bands and lines and a central area diffused with Mars-brown.

M. DARK REDDISH-BROWN BASE—Almost uniformly dark warm brown with occasional narrow spirals of the pale ground colour showing through towards outer edge.

N. DARK SEPIA BASE—Almost uniformly dark sepia with a few spirals of the pale ground colour towards outer edge and occasional light coloured axial streaks.

Callus:—

O. PALE BLUE GREY—Pallid greyish violet-blue.

P. DULL PURPLISH GREY.

Q. PURPLISH LILAC streaked with Argyle-purple (colour fugitive).

Size:—

R. FULL SIZE—attains 50-55 mm. (greatest diameter) and shows marked acceleration of last whorl.

S. REDUCED SIZE—attains 40-45 mm. and shows very slight acceleration of last whorl.

These letter symbols may be employed to express approximately the combination of factors in any one shell, and groups of such symbols with percentages added may be used to define the composition of a mixed colony. The letter symbols are quoted in sequence, one from each of the four headings, i.e., dorsal surface, ventral surface, callus and size. Thus the four forms of *traversi* which I propose to give nomenclatural status can be expressed as follows:—

*traversi traversi* Powell, 1930. ALPR
*traversi koputaroa* n. subsp. AHPR (see appendix).
*traversi florida* n. subsp. EMPR
*traversi tararuaensis* Powell, 1938. BIQR
*traversi otakia* n. subsp. FNOR

The type locality for *traversi* is Waiapehu Reserve, but unfortunately over collecting coupled with the depredations of rats, hedgehogs and thrushes has all but exterminated the species from this small

reserve of original forest. Study of the original topotypic series shows the colony to have been composite, for it is situated in an area of overlap and intergradation, such as obtains in the Mt. Kiwi region between the two Marlborough Sounds, where *obscura* and *bicolor* meet with the resultant hybrid forms. Analysis of the Waiapehu colony shows the following forms:—

ALPR 50% (*traversi* typical)
AJPR 20%
EMPR 30% (*traversi florida*)

The "Plain-top" *traversi* typical (ALPR), occurs at eight now isolated localities mostly within a radius of about two miles of Levin town. It is found to be most stable from the Levin town area to the north-western end of Papaitonga or Buller's lake but composes only 50% of the Waiapehu type locality which is near the eastern limit of dispersal for the "plain-top" typical form.

The "dark reddish-brown based" *florida* form (EMPR) is precinctive to the lower Ohau Valley and the foothills where the river emerges from the Ohau Gorge. Colonies from between the Ohau and Levin town show mixtures of these two forms. Past changes in the course of the Ohau River would explain this overlap. In an excellent paper by Mr. G. L. Adkin (Trans. N.Z. Inst. 43 pp. 496-520) it is presumed upon good evidence that the Ohau once flowed at a considerable distance north of its present course, passing through Lake Horowhenua, which is the dammed-up remnant of an earlier course of the river in Pleistocene times. It seems evident that the Ohau River has formed a fluctuating barrier to the free dispersal of the snails of the coastal plain even when the area was in virgin forest and that the development north of the river culminated in the "Plain-top" (ALPR) and that south of it in the dark-based (EMPR). Unfortunately the other two subspecies are completely and distantly isolated from the Levin colonies and thus we have no knowledge of intermediate forms which must have existed in the days of complete forest cover.

Three specimens taken by the Prouse cousins in September, 1945, are probably the last of a colony (doomed to destruction) from the coastal plain four miles north of Levin at Koputaroa. These are AHPR, and show closer relationship with the "pale-top" *traversi* typical than with *tararuaensis,* which seems to have been always a product of the high country.

The fact that snails from localities now completely isolated can be grouped into areas of distribution for a particular form is sufficient evidence that there was natural segregation of forms in pre-European times (point 1).

The table of factors given for the *traversi* series lists only the most striking forms, for there are many subtle variations difficult to define but obvious to the eye. With the dorsal pattern in particular it is noted that the Greenaway's locality produces a form which develops a few broad spiral bands, and similarly many of the artificially isolated local-

ities have colonies which collectively can be separated from other colonies by the presence of slight but recognisable differences. Therefore there is some grounds for surmising that present induced isolation resultant from the general clearing of the coastal plain between 1890 and 1900, is tending towards the production of further forms. Actually a new series of forms developing from and superimposed upon the wider areas of distribution of the former naturally restricted forms.

If the Levin snails survive in their present locations for say another fifty years, then a survey and analysis of the colonies may indicate if the above surmise is a reasonable one.

The Prouse cousins have established an experimental colony which may provide interesting data at some future time. One hundred snails from the Greenaway's locality (DMPR 70% + DKPR 30%), 925 feet, were liberated in a small forest reserve on the plain about two miles north of Levin, the locality being within the former range of *traversi* typical (ALPR). At the same time Mr. A. C. O'Connor liberated 40 examples of the Greenaway's snails at Khandallah. A duplicate series of 50 examples from Greenaway's have been prepared and are now deposited in the Auckland Museum as a standard to check any possible future variation in these newly established colonies. Both reserves were thoroughly searched prior to the liberation and proved to be without large snails. The reserve near Levin had been opened up by cattle at one stage but has since been fenced and is now approximately back to its original condition (point 2).

It seems fairly evident that in colonies which are persisting under adverse condtions there is a tendency towards smaller adult size without the normal acceleration of the last half whorl, and these factors are coupled with a general dark reddish-brown diffusion of the dorsal surface. Such snails occur at Shannon Heights and at Te Horo, and both these localities have been heavily trampled by cattle. These adverse conditions would appear to be reduced food supply, that is a scarcity of worms (they are carnivorous), and exposure to increased light and resultant dryness. Similar snails occur at Honore's, Jepson's and Stratton's, where the only cover is stunted second growth, fern and blackberry (point 3).

Colonies much reduced in numerical strength by being restricted to small areas often exhibit the most varied composition. Forest Reserve, which is contiguous with the general forest cover of the foothills has only one very constant form, but the nearby considerably reduced cover along the Ohau River at Florida Road shows three forms. Similarly Kaihinu, which until recently had extensive virgin cover, has a very stable form, but Waiapehu, a very small reserve, produced three forms.

I have already speculated upon the former courses of the Ohau River as a probable factor in the mixing of the *traversi* typical and *florida* subspecies, but there is a further factor to be considered, in that of genetics. In numerically small colonies there is not the same control of radical trends as in the case of a large colony where variants can be absorbed or swamped by mere numbers (point 4).

**Paryphanta traversi** Powell, 1930. Pl. 10, figs. 1 and 2.

1930. *Paryphanta traversi* Powell, Rec. Auck. Inst. Mus. Vol. 1, No. 1, p. 50.

The typical form of *traversi* is ALPR, that is, "plain-top," Isabella colour (light yellowish-brown), tinged with citrine, occasionally with weak spirals encroaching from the peripheral area. The base has a fairly open pattern of dark brown spiral bands and lines, and a central area of diffused Mars-brown, on a yellowish citrine to old gold ground. The parietal callus is dull purplish-grey. The holotype has a decidedly greenish tinge, but this has been acquired by long preservation in alcohol.

The typical species is a product of the Levin coastal plain, and occurred in its pure form mostly within a radius of two miles of Levin town. Its influence is apparent in composite colonies of the foothills behind Levin to as far west as the Makahika Stream, north to Koputaroa, and to a very small degree south of the Ohou. The type locality, Waiapehu Reserve, as already mentioned, is composite, with a strong admixture of EMPR, the *florida* form, due no doubt to meanderings of the lower course of the Ohau River.

| Major diameter: | Minimum diameter: | Height: | Depth of body-whorl: | |
|---|---|---|---|---|
| 53.5 mm. | 45.0 mm. | 27.0 mm. | 18.5 mm. | (R. A. Prouse's Bush.) |
| 51.5 mm. | 43.0 mm. | 25.5 mm. | 18.0 mm. | (Waiapehu Reserve) |
| 48.0 mm. | 40.0 mm. | 25.5 mm. | 17.0 mm. | (holotype). |

*Localities:* Levin, Buller's Lake, Papaitonga, North West corner, ALPR 100%; Buller's Lake, North East corner, 90 feet (= Government Experimental Farm of my 1930 paper) ALPR 60% + CM-KPR 30% + AHPR 10%; Waiapehu Reserve, 225 feet, 2¼ miles east of railway (type) ALPR 50% + (EMPR 30%) + AJPR 20%; Koputaroa, 4 miles north east of Levin, 100 feet, in very small remnant of lowland forest, now almost completely destroyed, AHPR and probably other forms (insufficient material); Levin, R. A. Prouse's Bush, 120 feet, a small reserve of ten acres near railway station AKPR 80% + AJPR 20%; H. S. Prouse's Bush, Queen St., 175 feet, Levin, AJPR 100%; Park's Bush, Kawiu Road, 130 feet, Levin, CJPR 60% + CHPR 40%; Honore's, 1 mile east of Waiapehu Reserve on foothills, 325 feet, persisting out in the open under water fern (Pteris scaberula) and introduced St. John's Wort (Hypericum perforatum), forest milled and area partially burned in 1893 (EMPS 80%) + CKPR 10% + AKPR 10%; Muhunoa East, Florida Road, 200-250 feet, south side of Ohau River (EMPR 90%) + AKPR 5% + ALPR 5%; Makahika River, Adkin's Bush, 415 feet AJPR 50% + CJPR 50%; Greenaway's Bush, foothills west of Makahika River, 925 feet, DMPR 70% + DKPR 30%; Shannon Heights, foothills between Koputaroa and headwaters of Makahika River, 925 feet (EMPS 70%) + CHPR 20% + DKPR 10%.

*NOTE.*—All localities are given where the typical species or a near approach to it were found, and the letter symbols plus the percentages indicate its relative strength in composite colonies. Where symbols are enclosed in parentheses these elements belong to the next subspecies *traversi florida*. The map (Plate 8) gives a better indication of the distribution of the two subspecies *traversi traversi* and *traversi florida*. The dorsal factor C, "the half-spiralled top," occurs as a buffer between the respective areas occupied by the two above-mentioned subspecies. Thus the "half-spiralled top" by its distribution is clearly the result of hybridization between them.

See Appendix for description of *traversi koputaroa* n. subsp. AHPR.

**Paryphanta traversi florida** n. subsp, **Pl. 10, figs. 3 and 4.**

This subspecies (EMPR) has a completely spirally lined top, diffused with reddish-brown, and a dark reddish-brown base with occasional narrow spirals of the light yellowish-brown ground colour, showing through, towards the outer edge. The parietal callus is dull purplish-grey. The spirals on the dorsal surface are very uneven in strength, some are clearly defined as dark lines and others are very fine and closely spaced in groups so that they appear as broad bands of paler colour. In the holotype there is a narrow spiral of ground colour above the periphery and four below it, the lowest situated on the base about one quarter of the radius in from the periphery. The result is four rather broad dark reddish-brown bands over the peripheral area.

| Major diameter: | Minimum diameter: | Height: | Depth of body-whorl: |
|---|---|---|---|
| 49.5 mm. | 41.0 mm. | 24.0 mm. | 18.5 mm. |
| 48.5 mm. | 40.0 mm. | 26.0 mm. | 18.5 mm. (holotype) |

*Localities:* Forest Reserve, Muhunoa East, foothills towards Ohau Gorge, 400-500 feet EMPR 100% (type); Jepson's and Stratton's 400-500 feet, ½ to 1 mile south of Forest Reserve on cleared land, persisting in the open under fern and blackberry EMPS 80% + EKPS 20%; Florida Road, Muhunoa East, 200-250 feet, south side of Ohau River EMPR 90% + (AKPR 5% + ALPR 5%); Kirkcaldie's Bush, a small reserve to the south of the Ohau River, EKPR 100%; Kimberley Road, 225 feet, north side of Ohau River, EMPR 50% + (DKPR 50%); Waiapehu Reserve, 225 feet (type locality for *traversi*) (ALPR 50%) + EMPR 30% + (AJPR 20%); Honore's, 1 mile east of Waiapehu Reserve on foothills, 325 feet under fern, etc., EMPS 80% + (CKPR 10% + AKPR 10%); Shannon Heights, foothills between Koputaroa and headwaters of Makahika River, 925 feet, EMPS 70% + (CHPR 20% + DKPR 10%). *NOTE:* In the composite colonies the use of parentheses indicates the percentage which relates to the previous subspecies *traversi* typical.

*Holotype:* Auckland Museum.

**Paryphanta traversi tararuaensis** Powell, 1938.

1938 *Paraphanta traversi tararuaensis* Powell. Rec. Auck. Inst. Mus. Vol. 2, No. 3, p. 138.

This is the only high country occurrence for the *traversi* series so far known. It seems to be fairly restricted in the vicinity of Kaihinu at 1500-2000 feet, about four miles east of Tokomaru on a western outlier of the Tararua Range. The actual type locality was a small forest remnant about a mile west of Kaihinu Peak, but through general thinning of the area by cattle the chance of survival of the subspecies at the actual type locality is slender.

This high country form is BIQR, that is, dorsal surface olive-lake to Dresden-brown, diffused and partially to completely spirally lined, but not banded with Mars-brown. The ventral surface is greenish-olive with faint to moderate dark, narrow, spiral lines of olive and Roman-green and a central diffused patch of Mars-brown. The parietal callus is purplish-lilac streaked with Argyle-purple, but this colouring is very fugitive and quickly fades to a dull grey.

| Major diameter: | Minimum diameter: | Height: | Depth of body-whorl: |
|---|---|---|---|
| 52.5 mm. | 43.0 mm. | 25.0 mm. | 19.0 mm. |
| 50.0 mm. | 41.0 mm. | 24.0 mm. | 17.5 mm. |
| 43.0 mm. | 35.0 mm. | 22.0 mm. | 16.0 mm. (holotype) |

**Paryphanta traversi otakia** n. subsp. **Pl. 10, figs. 5 and 6.**

This, the Otaki subspecies, FNOR, is the most southern occurrence of the *traversi* series. It is separated from the *florida* subspecies by nine miles of coastal plain from which the forest has been removed entirely. Except for the Te Horo occurrence no *Paryphanta* has been found on the foothills until the Ohau area to the north is reached.

Ground colour olive-lake. Dorsal surface more or less completely covered with a spiral pattern of closely-spaced, narrow, slightly wavy, dark reddish-brown lines, crossed by irregular narrow dark-brown axial streaks which follow the growth lines. Ventral surface with an all-over zone of dark warm-sepia which is broken up below the periphery by three narrow interrupted lines of the olive-lake ground colour. This gives the effect of three broad sub-peripheral bands.

Parietal callus pale blue-grey; pallid greyish violet-blue (Ridgway). The variation is not great—some have the top spirals rather sparse, showing more of the olive-lake ground; others are so densely lined that they appear dark reddish-brown. The ventral surface is very constant—some show occasional axial streaks of the pale ground colour and others a varying number of subperipheral spirals.

About 20% of the examples collected at Te Horo are of stunted growth, and have the dorsal surface strongly diffused with dark reddish-brown (i.e., GNOS compared with FNOR for the typical form). I have already referred to this tendency towards smaller adult size, lack of acceleration of the last whorl, and a general dark reddish-brown diffusion of the dorsal surface. These factors are almost invariably associated with colonies which are persisting under the adverse conditions of increasing light and dryness, occasioned by the opening up of the bush with the trampling of the undergrowth by cattle.

| Major diameter: | Minimum diameter: | Height: | Depth of body-whorl: |
|---|---|---|---|
| 50.0 mm. | 40.5 mm. | 25.0 mm. | 18.0 mm. |
| 49.0 mm. | 40.25 mm. | 25.0 mm. | 18.0 mm. |
| 48.0 mm. | 39.5 mm. | 26.0 mm. | 18.0 mm. (holotype) |

*Localities:* Rahui Road, 200 feet, Otaki (type FNOR 100%) near Te Horo 300-400 feet. (FNOR 80% + GNOS 20%). These localities are about three miles apart and are situated to the north and to the south of the Otaki River, respectively.

*Holotype:* Auckland Museum.

Unfortunately the chance of survival of this subspecies appears slender unless further colonies are located. The Rahui Road type locality yielded a small series only, but a few were left, including all juvenile and half-grown examples. The Te Horo locality is about ten acres in extent, but much of it has been thinned, and trampled by cattle, and in consequence snails are very scarce.

This subspecies was discovered by Messrs. R. A. and H. S. Prouse. It bears a striking resemblance to some of the hybrid forms of *obscura* x *bicolor* from the Mount Kiwi area of the Marlborough Sounds, the only marked difference being that *obscura* and *bicolor* have the deep body-whorl of the *hochstetteri* series, but the *traversi* subspecies has the shallow body-whorl as in the West Nelson *gilliesi* group.

If the *gilliesi* group arose from the *lignaria* series as a small shallow-whorled mutation, then there is no reason why a similar but separate origin cannot be claimed for the *traversi* series from a prototype of the *obscura-bicolour* series.

To derive the *traversi* series from the Marlborough Sounds area rather than from the *gilliesi* series which lie much further westward is more natural, and is in accord with the main axial dispersal of *Wainuia* both north and south of Cook Strait.†

The position is complicated by *marchanti*, which shows alliance with the eastern Marlborough *bicolor* but occurs along the high country of the Ruahine Range, there being no record, so far, of snails of this deep-whorled group from the Tararua Range.

Further speculation is not warranted until the high country of the Tararua Range is more thoroughly searched.

†Since the above was written a most interesting occurrence has been brought to my notice by Miss L. B. Moore and Mr. W. Harris of the Plant Research Bureau, Wellington. Collapsed shells of a *Paryphanta* closely resembling a small *obscura* (46.5 mm.) were found not uncommonly at the Wallaceville Swamp, an area of peat bog in the Mungaroa Valley just east of the main Hutt Valley, Wellington.

They were on the surface of the peat, not embedded, under cover of a derelict *Phormium* plantation.

My revised contention that *traversi* probably originated from Marlborough Sounds *obscura-bicolor* stock has been strengthened by this unexpected new record. There is a possibility that this snail still lives in the vicinity and pending an exhaustive search I withold description of the imperfect material so far available.

## Genus **WAINUIA** Powell, 1930.

Type (o.d.): HELIX URNULA Pfeiffer.

Mr. L. C. King (1939) has presented an interesting hypothesis in "that the central segment of New Zealand has been subjected to intense shearing stress associated with the later stages of the compression which formed the New Zealand mountain ranges. This has resulted in the rupture of once-continuous geological and topographical features and the development of a definite offsetting between the North and South Islands."

By a series of structural maps King shows firstly the conjoined islands in such a position that the main axes of both islands were united, as also were the Kaikoura Mountains of the South with the Haurangi Mountains of the North, these combined systems then lying eastward and parallel to the main axis. The South Island is then assumed to have moved westward and northward in relation to the North Island, disrupting the continuity of the above-mentioned parallel systems. As the southern portion of the united islands moved to the west, the Marlborough Sounds triangular block tended to stay with the North Island, so that a split developed between it and the mountainous country of North-west Nelson (i.e., Tasman Bay). "When further movement of the South Island relative to the North Island occurred, the Marlborough Sounds block was also carried to the west, opening up a new rift which now forms Cook Strait."

In the light of the above hypothesis, new locality records for *Wainuia urnula* are of interest. The typical species is now known from the Tararua and Rimutaka Systems of the North Island, Kapiti Island, Ruahine Range and (a new subspecies, described herein) D'Urville Island. The D'Urville Island occurrence is now the only authentic record of an *urnula* type in the South Island, and its position to the westward of Kapiti Island and the Tararua-Rimutaka main axial distribution is significant.

The Kaikoura *Wainuia* occurrences are now regarded as a new species more akin to the North Canterbury *edwardi* than to *urnula*. If there is a *Wainuia* on the Haurangi Mountains of the North Island it should show affinity with *edwardi* rather than with *urnula*.

The only other *Wainui* is *clarki* Powell, 1936, from the recent volcanic island of Motutaiko in Lake Taupo, a problematic occurrence. Intensive collecting on the intervening high country in both islands will be necessary to reveal the complete order of dispersal of this interesting genus.

**Wainuia urnula** (Pfeiffer, 1855). Text figs. B8-10; C3.

*Localities:* Ridge at back of Lowry Bay, 1,000 feet; Butterfly Creek near Day's Bay, 400 feet; Korokoro, near Petone, 800 feet; Wainuiomata, 1200 feet (type); Rimutaka Mountains, 1,700 feet; Khandallah, 1,000 feet; Porirua, 50 feet (empty shells) (A. C. O'Connor); Paraparaumu, 2,000 feet (H. Hamilton); Rahui Road, Otaki, 200 feet; Waikawa River, Manakau, 500 feet (R. A. and H. S. Prouse); Mt. Holdsworth (H. W. Simmonds); Tokomaru-Mangahao Divide, 3,000 feet; Tararua Range; Kapiti Island, 1,700 feet; Copper Creek, foothills of Ruahine Range, ten miles north of Woodville; Mokai-Patea Trig, Ruahine Range, 3,600 feet (A. C. O'Connor).

**Wainuia urnula nasuta** n. subsp. Pl. 9, fig. 9. Text figs. B11-14.

Examples collected by Mr. A. C. O'Connor at 2,000 feet on D'Urville Island, Cook Strait, are readily distinguished from typical *urnula* by a constant difference in coiling, which results in relatively lower height and a more produced termination to the body-whorl. Viewed from above, the coiling in *urnula* is normally helicoid except for the last quarter of the body-whorl which swings outward at an increasing rate. In *nasuta* acceleration commences earlier, at the last third of the body-whorl, and swings outward with even greater rapidity. Again viewed from above, the outer lip has a narrowly pointed termination, low down, in *urnula*, but this is bluntly rounded and higher up in *nasuta* (point X in text figures). Also the minimum diameter is proportionately less in *nasuta*. These essential differences are more clearly shown by the diagrams and the dimensions given below. Several senile examples have the last sixth of the body-whorl suddenly incurved, causing a humped outline to the periphery. Coloration, radial corrugations and width of the umbilicus are as in the typical species.

Dimensions of *urnula* and *urnula nasuta*.

| | Major diameter: | Minimum diameter | Height: | |
|---|---|---|---|---|
| *urnula* | 25.5 mm. | 19.5 mm. | 18.5 mm. | (Manakau) |
| | 24.5 mm. | 17.5 mm. | 16.5 mm. | (Manakau) |
| | 24.25 mm. | 17.75 mm. | 17.0 mm. | (Paraparaumu) |
| | 24.0 mm. | 18.0 mm. | 17.0 mm. | (Wainuiomata) |
| | 22.0 mm. | 16.0 mm. | 15.0 mm. | (Wainuiomata) |
| | 16.0 mm. | 13.0 mm. | 9.0 mm. | (type) |

| | | | | |
|---|---|---|---|---|
| *nasuta* | 27.5 mm. | 20.0 mm. | 16.8 mm. | |
| | 26.5 mm. | 18.0 mm. | 16.5 mm. | (type) |
| | 26 2 mm. | 19.5 mm. | 16.35 mm. | |
| | 25.2 mm. | 18.3 mm. | 16.0 mm. | |

*Locality:* Mount Maude, 2,000 feet, D'Urville Island Cook Strait (A. C. O'Connor, 12:10:1942).

*Holotype:* Auckland Museum.

The writer is indebted to Dr. R. A. Falla for the loan of series of *Wainuia* from five North Canterbury and Marlborough localities. These can be readily separated into three forms, two of them of specific value and the third probably a subspecific form of one of them (*edwardi*). Their distribution is as follows.

(1) *edwardi* (Suter, 1899), Hossack Downs (type); Little Lottery Creek, 1,000 feet (H. E. Fyfe), N.E. of Hamner, North Canterbury. This is the largest species of the genus (37 mm. x 27.5 mm. x 22.5 mm., Little Lottery Creek), it has oblique radiate plications, the umbilicus is comparatively large and when adult, but only then, the last half-whorl shows considerable acceleration.

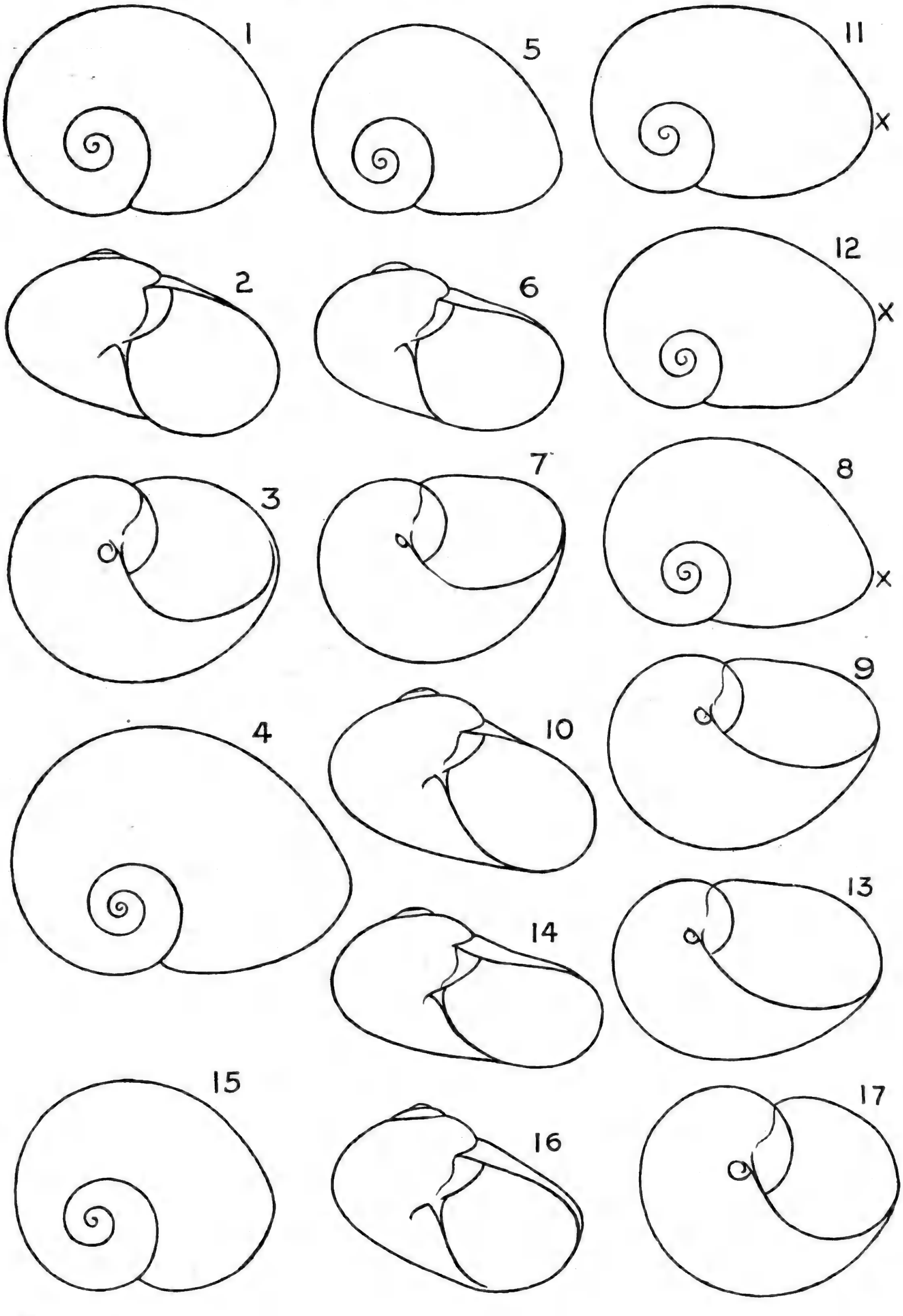
(2) *edwardi* n. subsp.? Mount Oxford, North Canterbury. These are probably a constantly smaller form of *edwardi* (26 mm. x 20.5 mm. x 18.5 mm.). It has a comparatively large umbilicus, is more strongly obliquely plicate than *edwardi* typical and shows considerable acceleration of the last half-whorl. Typical *edwardi* at this size does not show acceleration. In *fallai* the umbilicus is small and there are no radial plications.

(3) *fallai* n. sp. Seaward Kaikouras, 450-1,500 feet. This is the species which was the basis of my 1930 (p. 52) South Island records of *urnula*. It is about the size of *urnula* (24.5 x 19.0 mm. x 17 mm.), but does not obtain the extreme acceleration of the last whorl of that species. By its dentition it is related to *edwardi* rather than to *urnula* and it differs from both in having the plications obsolete. The umbilicus differs from that of *edwardi* in being very small as in *urnula*.

**Wainuia fallai** n. sp. Pl. 9, figs. 7 and 8; Text figs. B5-7; C5.

Shell small, about the size of the North Island *urnula*, but of more circular outline with very slight acceleration of the last whorl, almost smooth, and with a very small umbilicus. Whorls $3\frac{1}{2}$; protoconch and early whorls buff to light brown; body-whorl dark sepia, almost black. Sculpture subobsolete, weak closely-spaced radials on the protoconch, faint malleations on the spire whorls but the transverse folds almost completely obsolete. The whole surface bears very indistinct microscopic irregular spiral striations. Umbilicus very small and half hidden by the reflected inner lip.

*Dentition:* Very similar to that of *edwardi*. Formula 24 + 1 + 24, compared with 26 + 1 + 26 for both *edwardi* and *clarki*, 14 + 1 + 14 for *urnula* and 27 +1 + 27 for the Mt. Oxford subspecies. (Text fig. C.)




**Text Fig. B.**

1-3. *Wainuia edwardi* (Suter, 1899). Hossack Downs (immature).
4. *Wainuia edwardi* (Suter, 1899). Hossack Downs (Paratype).
5-7. *Wainuia fallai* Powell, n. sp. Monkeyface, Kaikoura.
8-10. *Wainuia urnula* (Pfeiffer, 1855). Manakau, Wellington.
11-14 *Wainuia urnula nasuta* Powell, n. subsp. D'Urville Island.
15-17. *Wainuia clarki* Powell, 1936. Motutaiko Island, Lake Taupo.

(All figures to uniform scale of $1\frac{1}{4}$)

At present there is insufficient material to warrant separating the Mt. Oxford shell, which is presumed to be subspecifically distinct, from *edwardi.*

The species is named in recognition of the fact that Dr. Falla had previously claimed the Kaikoura snails to be distinct.

*Localities:* Mount Fyfe, Kaikoura; Kaikoura, 400 feet; Monkeyface, Kaikoura (type, R. A. Falla); Lower end of Monkeyface Ridge (A. G. Macfarlane); Mount Ross, Seaward Kaikouras, 450-1,500 feet (R. A. Falla).

*Holotype:* Canterbury Museum, Christchurch.

| Major diameter: | Minimum diameter: | Height: | |
|---|---|---|---|
| 24.5 mm. | 19.0 mm. | 17 mm. | (holotype) |
| 25.0 mm. | 19.0 mm. | 17 mm. | (paratype) |

**Wainuia clarki** Powell, 1936. Text figs. B15-17; C4.

1936 *Wainui clarki* Powell, Rec. Auck. Inst. Mus, Vol. 2, No. 1, p. 36.

*Locality:* Motutaiko Island, Lake Taupo.

I am indebted to Mr. A. G. Stevenson for the animal of this species. The numerical formula of the radula is 26 + 1 + 26, the same as for the South Island *edwardi,* but in the North Island *urnula* it is only 14 + 1 + 14. The other South Island species, *fallai,* has numerous teeth also, 24 + 1 + 24. Both on shell features and in dentition *clarki* shows closer relationship with the South Island species than it does with *urnula.*

Since *urnula* has the lower main axial distribution for the North Island (Tararua and Ruahine Ranges) it is problematic why a *Wainuia* not allied to *urnula* is found to the west of the main axis. The Kaimanawa Mountains between Taupo and the main axis, the Huiarau and Raukumara Mountains of the Middle and Upper sections of the main axis as well as the East Wellington systems, the Haurangi and Maungaraki Mountains and Puketoi Hills, all require investigation before useful comment can be made upon the apparently anomalous distribution of *clarki.*

## Genus **RHYTIDA** Albers, 1860.

Type: HELIX GREENWOODI Gray.

**Rhytida meesoni** Suter, 1891. Text figs. D10-11.

1891 *Rhytida meesoni* Suter. Trans. N.Z. Inst. Vol. 23, p. 84.
1913 *Rhytida meesoni* Suter. Man. N.Z. Moll. p. 776, Pl. 50, f. 13.
Major diameter 11.5 mm.; minimum diameter 9 mm.; height 6 mm. (holotype).

*Localities:* Wairoa Gorge Nelson (type); Kenepuru (McMahon); Manaroa, Pelorous Sound (A. C. O'Connor).

Suter (1913 l.c.) records this species from Collingwood, West Nelson and Hossack Downs, North Canterbury. I have not seen Hossack Downs material, but the Collingwood record belongs to the new subspecies described below.

**Rhytida meesoni perampla** n. subsp. Text figs. D7-9.

The dimensions given by Suter for *meesoni* are about the maximum for the typical species, which seems to be restricted to Eastern Nelson and the Marlborough Sounds. All occurrences from the Pikikiruna Range and North Western Nelson Province are much larger than *meesoni* typical and are more strongly radiately malleated.

Whorls $3\frac{3}{4}$, the last considerably accelerated towards its termination. Dorsal surface sculptured with rather strong dense malleations, fold-like, anastomosing and retractively arcuate, but confused over the last half whorl. The spiral striations are microscopic and subobsolete. Umbilicus one-tenth the major diameter of the base.

In *meesoni* the whorls are slightly less than $3\frac{3}{4}$, the last half whorl accelerates in similar fashion, but the malleations are weak, the spiral striations much stronger, and the umbilicus is one-sixth the major diameter of the base.

Half grown *perampla* of equal size to adult *meesoni* afford the best basis of comparison for the differences in sculpture.

| Major diameter: | Minimum diameter: | Height: | |
|---|---|---|---|
| 15.0 mm. | 11.0 mm. | 8.5 mm. | (holotype) |
| 15.0 mm. | 11.2 mm. | 8.5 mm. | (Takaka Saddle) |
| 14.25 mm. | 11.0 mm. | 8.0 mm. | (Anatoki Forks) |

*Localities:* Takaka Saddle, Pikikiruna Range, 2,700 feet (A.W.B.P. 23:12:1927); Anatoki Forks, West Nelson, 2,400 feet (type) (A. C. O'Connor); Quartz Range, east of Bainham, 500-600 feet (A. C. O'Connor); Paturau River, West Nelson (H. S. Prouse, -:3:1941).

*Holotype:* Auckland Museum.

Since the above was written Mr. A. C. O'Connor has provided an animal of *perampla* from Takaka. The formula is 14 + 1 + 14, increasing to the fourteenth, which is largest, and medially ridged as in the *patula* series. Suter gives the formula for *meesoni* as 12 + 0 + 12, increasing to the tenth, which is largest. Re-examination of the *meesoni* radula is now required to determine if the largest tooth is medially ridged also.

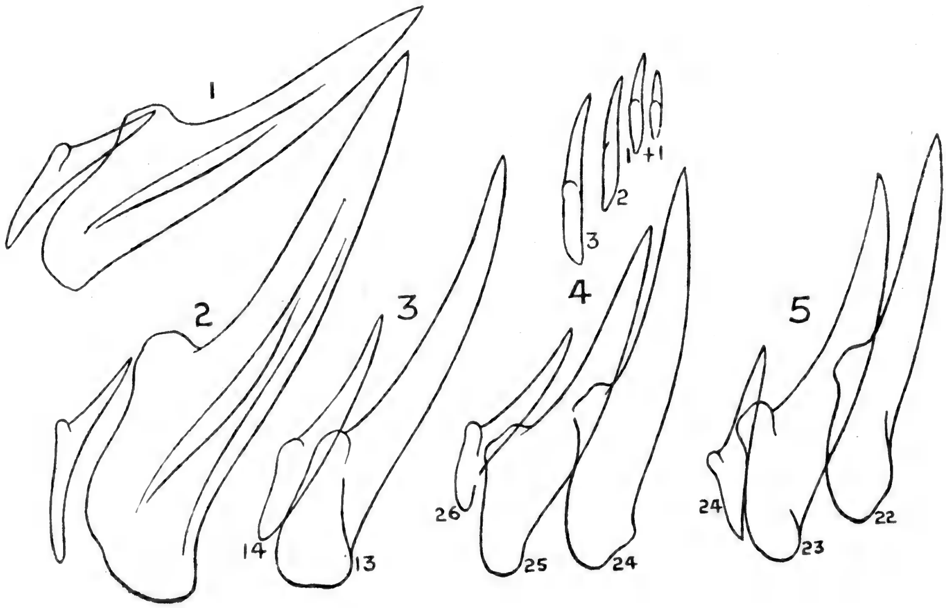
**Rhytida patula** Hutton, 1833. Text figs. D4-6; C2.

1883 *Rhytida patula* Hutton, Trans. N.Z. Inst. Vol. 15, p. 139.

| Major diameter: | Minimum diameter: | Height: | |
|---|---|---|---|
| 23 0 mm. | 16.3 mm. | 12.0 mm. | (Lectotype) |
| 19.5 mm. | 14.5 mm. | 12.0 mm. | (co-type) |
| 17.2 mm. | 13.0 mm. | 10.5 mm. | (co-type) |
| 20.0 mm. | 15.0 mm. | 12.0 mm. | (St. Helens) |
| 20.0 mm. | 15.0 mm. | 12.0 mm. | (Oyster Point) |

*Localities:* Greymouth (type); Capleston near Reefton; Lake Kanieri (A. C. O'Connor); St. Helens, Mokihinui (A.W.B.P. 27/12/1927); Oyster Point, West Haven Inlet (H. S. Prouse).

The largest of Hutton's series of six co-types is here selected as Lectotype.




**Text Fig. C.**

DENTITION.

1. *Rhytida citrina* Hutton, 1883. Buller River, Nelson.
2. *Rhytida patula* Hutton, 1883. Oyster Point, West Haven Inlet.
3. *Wainuia urnula* (Pfeiffer, 1855), 14 + 1 + 14. Wainuiomata, Wellington.
4. *Wainuia clarki* (Powell, 1936), 26 + 1 + 26. Motutaiko Is., Lake Taupo.
5. *Wainuia fallai* Powell, n. sp., 24 + 1 + 24. Kaikoura.

**Rhytida citrina** Hutton, 1883. Text figs. D1-3; C1.

1883 *Rhytida citrina* Hutton, Trans. N.Z. Inst. Vol. 15, p. 139.

| Major diameter: | Minimum diameter: | Height: | |
|---|---|---|---|
| 22.0 mm. | 17.0 mm. | 12.5 mm. | (Maruia Springs) |
| 19.0 mm. | 15.0 mm. | 12.0 mm. | (Rewanui) |
| 18.5 mm. | 15.0 mm. | 11.5 mm. | (Buller River) |
| 16.25 mm. | 12.5 mm. | 10.0 mm. | (Lake Kanieri) |
| 9.0 mm. | 7.0 mm. | 6.0 mm. | (Lake Kanieri) |
| 7.75 mm. | 6.0 mm. | 6.0 mm. | (largest co-type)* |

*Localities:* Greymouth (type); Seven Mile Creek, Rewanui, North of Greymouth (A. C. O'Connor); Otira, 2 miles below railway station (A.W.B.P. 30:12:1927); Lake Kanieri (A. C. O'Connor); Maruia Springs, Lewis Pass (R. A. Cumber).

*Suter gave these dimensions for the largest of the three type specimens which he noted is evidently not adult. I have not seen the types which Dr. Falla has been unable to locate in the Canterbury collections. Two of Hutton's Greymouth specimens in the Canterbury Museum are 5.5 mm. and 8.5 mm., respectively, major diameter.

Both *patula* and *citrina* were described from Greymouth material, but the latter unfortunately was a juvenile. From Greymouth to the Buller River two forms occur, a reddish-brown one with a greatly accelerated last whorl which is definitely *patula,* and a yellowish-olive one with closely coiled whorls which is almost certainly the adult of *citrina.* In North West Nelson, only the reddish-brown *patula* occurs and the absence there of a *citrina* form would indicate that there are two species, for the two are not entirely coincident in range.

Since Hutton's type of *citrina* was a juvenile, the radula differences he noted (Hutton, Trans. N.Z. Inst. 16, p. 167) probably do not obtain in the adult. A specimen labelled *citrina* by Hutton from Buller River is in the Canterbury Museum. It is an adult, or nearly so, of 18.5 mm. diameter, and has closely coiled whorls and the yellowish-olive coloration of *citrina.* This specimen had the animal dried hard within the shell,, but I was able to soften it and mount the radula. The dentition is not as Hutton described it for his juvenile type, 17+0+17, with the fifteenth tooth larger than the sixteenth, but much nearer to that of *patula.* Hutton gave the dental formula for his *patula* as 18+0+18, outermost tooth very small, seventeenth the largest and bearing a central ridge. Hutton's Buller specimen has the formula of 16+1+16 and the outermost tooth is very small followed by the largest, which is ridged as in *patula.* The Oyster Point, West Haven Inlet specimens are typical *patula,* both on shell characters and in dentition, that is, 18+0+18 with the seventeenth tooth strongly ridged. The fact that the nascent portion of the radula in the Buller specimen shows the teeth to be much more aculeate and without the ridge on the largest tooth is almost conclusive evidence that my interpretation of the adult *citrina* is correct. It may be noted that my *R. otagoensis* (Powell 1930, p. 32) belongs to the *patula-citrina* group, for it has the largest tooth similarly ridged, but the formula is 14 + 0 + 14.

**Rhytida oconnori** n. sp. Pl. 9, fig. 10. Text figs. D12-14.

The shell resembles that of *patula,* but is more tightly coiled, with a larger, more circular aperture, a proportionately greater minimum diameter and peripheral ridges additional to the normal radiate malleations. Whorls $3\frac{3}{4}$, including a flat protoconch of $1\frac{1}{2}$, finely radiately ribbed whorls. Dorsal surface of post-nuclear whorls malleated by a laterally compressed network of anastomosing radial ridges. Ventral surface with numerous, simple, fine, radial growth lines. Periphery narrowly rounded, bearing about six irregular, rather strong, upwardly inclined spiral ridges. Aperture large, subcircular, much advanced above. Umbilicus deep, about one fourteenth the major diameter.

The species is a combination of the *patula* form and the *greenwoodi* peripheral ridges. Its actual relationship would appear to be nearer to the former.

| Major diameter: | Minimum diameter: | Height: | |
|---|---|---|---|
| 26.3 mm. | 21.0 mm. | 16.0 mm. | (Paratype, A. C. O'Connor) |
| 20.75 mm. | 16.5 mm. | 13.5 mm. | (Holotype) |
| 26.0 mm. | 21.0 mm. | 17.0 mm. | (Paratype) |
| 20.5 mm. | 15.0 mm. | 12.0 mm. | (*patula*) |
| 20 0 mm. | 15.0 mm. | 12.0 mm. | (*patula*) |

*Locality:* Punipaua Creek, subfossil in cave with moa bones, two miles down the coast from Paturau River and one-third of a mile in from the sea coast.

*Holotype:* Auckland Museum.

Discovered by Mr. A. C. O'Connor and here named in recognition of both his able field work and his excellent paper on the eggs of the *Paryphantidae* (1945).

**Rhytida duplicata** Suter 1904. Text figs. D15-16.

1904 *Rhytida duplicata* Suter, Proc. Malac. Soc. Lond. Vol. 6, p. 155.

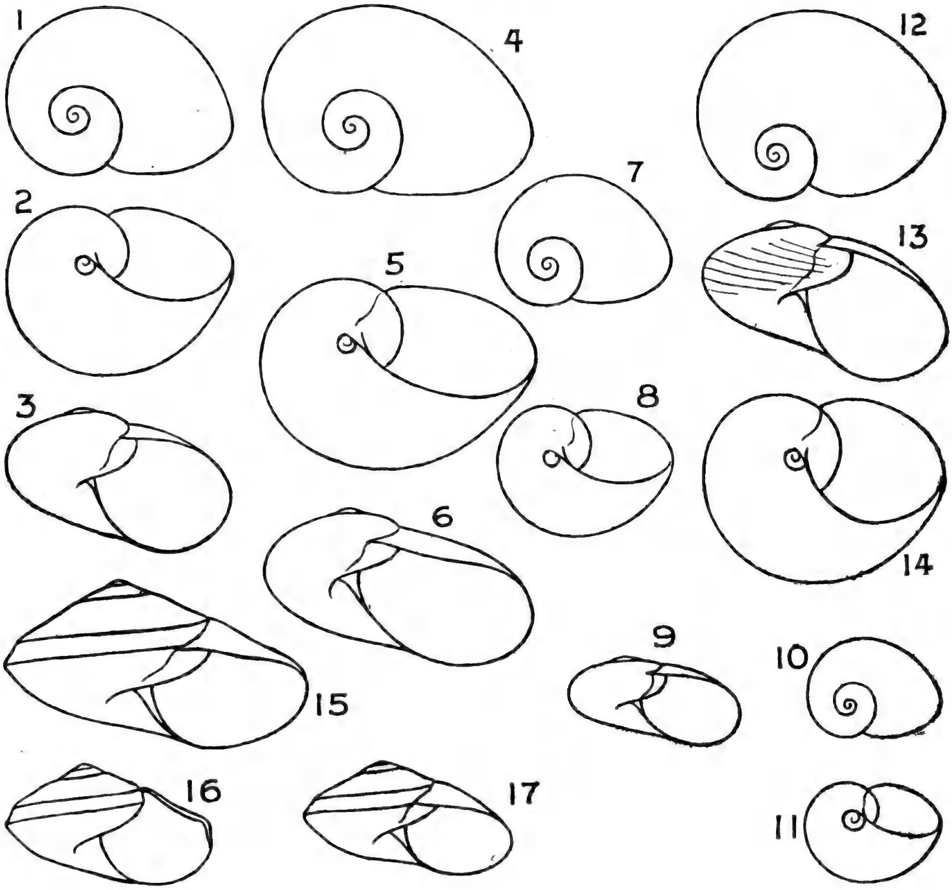
*Localities:* Cape Maria van Diemen (type); Cape Maria van Diemen, mainland, in consolidated dunes (A.W.B.P., Feb., 1932); Tom Bowling Bay, in consolidated dunes (A.W.B.P. and C. A. Fleming, Feb., 1932).

In 1932 (Rec. Auck. Inst. Mus. Vol 1, No. 3, p. 155) the writer recorded living examples of this species from the "Far Northern Block," but it is now proposed to separate subspecifically the living form from the subfossil type.

**Rhytida duplicata vivens** n. subsp. Text fig. D17.

1932 *Rhytida duplicata*: Powell, Rec. Auck. Inst. Mus. Vol. 1, No. 3, p. 155 (in part) Recent localities and figure of radula, Text fig. 4.

The only difference between the subfossil type and the Recent subspecies is the constant smaller size of the latter. In *duplicata* the adult shell has $4\frac{1}{2}$ whorls and has a maximum diameter of 26 mm., but the largest *vivens* found has $4\frac{1}{4}$ whorls and a maximum diameter of only 18.5 mm. Examples of *duplicata* of the size of the largest *vivens* are definitely juvenile, for they lack acceleration of the last whorl and the aperture is thin, angulated, and its upper margin does not descend




**Text Fig. D.**

1-3. *Rhytida citrina* Hutton, 1883. Rewanui, Greymouth.
4-6 *Rhytida patula* Hutton, 1883. Greymouth (Lectotype).
7-9. *Rhytida meesoni perampla* Powell, n. subsp. Anatoki Forks, West Nelson.
10-11. *Rhytida meesoni* Suter, 1891. Manaroa, Pelorus Sound.
12-14. *Rhytida oconnori* Powell, n. sp. Subfossil. Punipaua Creek, West Nelson.
15. *Rhytida duplicata* Suter, 1904. Subfossil. Cape Maria van Diemen.
16. *Rhytida duplicata* Suter, 1904. Subfossil (immature). Cape Maria van Diemen.
17. *Rhytida duplicata vivens* Powell, n. subsp. Unuwhao, North Auckland. (adult, holotype).

(All figures to uniform scale of $1\frac{1}{2}$)

to the level of the lower carina, a feature common to the adults of both species and subspecies. Three field trips have failed in the finding of *vivens* of larger size than 18.5 mm.

| Major diameter: | Minimum diameter: | Height: | |
|---|---|---|---|
| 26.0 mm. | 21.0 mm. | 15.0 mm. | (*duplicata*, Cape Maria) |
| 25.5 mm. | 21.0 mm. | 15.0 mm. | (*duplicata*, Cape Maria) |
| 24.0 mm. | 20.0 mm. | 14.0 mm. | (*duplicata*, Cape Maria) |
| 24.0 mm. | 20.0 mm. | 12.0 mm. | (*duplicata*, holotype) |
| 18.5 mm. | 15.5 mm. | 11.0 mm. | (*vivens*) |
| 18.25 mm. | 14.5 mm. | 10.5 mm. | (*vivens*, holotype) |

*Note.*—All dimensions are of adult shells.

A single egg was found in February, 1932. It is white, calcareous, 3 mm. x 2.5 mm., and without a cuticle.

*Dentition:* 15 + 1 + 15 (Powell, 1932, l.c.).

*Localities:* Unuwhao, 900-950 feet, near track between Spirits Bay and Tom Bowling Bay under decaying leaves in coastal forest. (A.W.B.P., Feb., 1932); Kahuronaki (Kahoroa on survey maps), between Te Paki and Kapo-Wairua Road (A.W.B P., Feb., 1944); near North Cape (R. A. Falla, Feb., 1932).

*Holotype:* Auckland Museum.

## FAMILY PARYPHANTIDAE.

(Synopsis of the New Zealand members of the family)

### Genus 1. **Rhytida** Albers, 1860

(Type: HELIX GREENWOODI Gray)

(1) *R. greenwoodi* (Gray, 1850) North of Auckland to northern part of South Island.
(2) *R. stephenensis* Powell, 1930. Stephen Island, Cook Strait.
(3) *R. spelaea* Powell, 1933, Subfossil, Hawkes Bay.
(4) *R. dunniae* (Gray, 1840), Kaitaia to Thames.
(5) *R. tarangaensis* Powell, 1930. Taranga, Hen and Chickens Islands.
(6) *R. pycrofti* Powell, 1932. Poor Knights Islands.
(7) *R. duplicata* Suter, 1904. Subfossil, Cape Maria van Diemen.
(8) *R. duplicata vivens* Powell, n. subsp. Unuwhao, extreme north, N.Z.
(9) *R. patula* Hutton, 1883. Greymouth to West Nelson.
(10) *R. citrina* Hutton, 1883. Greymouth to Reefton.
(11) *R. oconnori* Powell, n. subsp. Subfossil, Punipaua Creek, West Nelson.
(12) *R. meesoni* Suter, 1891. East Nelson and Marlborough.
(13) *R. meesoni perampla* Powell, n. subsp. West Nelson.
(14) *R. otagoensis* Powell, 1930. Southland.
(15) *R. australis* Hutton, 1883. Stewart Island.

### Genus 2. **Paryphanta** Albers, 1850.

(Type: HELIX BUSBYI Gray)

#### Subgenus **Paryphanta** Albers, 1850.

(1) *P. busbyi* (Gray, 1840), Kaitaia to Kaipara; Poor Knights Islands; Hen and Chickens.
(2) *P. watti* Powell, n. sp. Extreme north of N.Z.

## Subgenus **Powelliphanta** O'Connor, 1945.

(Type: HELIX HOCHSTETTERI)

(a) ROSSIANA series.

(3) *P. spedeni* Powell, 1932. Opposite East Dome, Southland.
(4) *P. spedeni lateumbilicata* Powell, n. subsp. Billow Mountains, near Lake Monowai.
(5) *P. rossiana* Powell, 1930. Mount Greenland, Ross, Westland.
(6) *P. fletcheri* Powell, 1938. Mt. Tuhua, Westland.
(7) *P. gagei* Powell, 1938. Rewanui, Greymouth; Kirwan's Hill, Reefton.

(b) LIGNARIA series.

(8) *P. unicolorata* Powell, 1930. Seddonville, on the flat.
(9) *P. unicolorata rotella* Powell, 1938. Western slopes of Mt. Glasgow.
(10) *P. unicolorata johnstoni* Powell, n. subsp. Western side of Chasm Creek, Seddonville.
(11) *P. lignaria* Hutton, 1888. Lyell Range (type) and Mokihinui River to Karamea?
(12) *P. lignaria oconnori* Powell, 1938. Leslie River; Western slopes of Mt. Arthur.
(13) *P. annectens* Powell, 1936 Karamea to Heaphy River.
(14) *P. superba* Powell, 1930. High country, both east and west of Aorere Valley, West Nelson.
(15) *P. superba prouseorum* Powell, n. subsp. Between Kahurangi Point and Rocks Point, West Nelson.
(16) *P. superba harveyi* Powell, n. subsp. Heaphy section of Gouland Downs track, West Nelson.
(17) *P. superba mouatae* Powell, 1936. Near Saxon Creek, Gouland Downs.
(18) *P. superba richardsoni* Powell, n. subsp. Perry's Pass, Gouland Downs.

(c) GILLIESI series.

(19) *P. gilliesi* (Smith, 1880). Northern end of Wakamarama Range, West Nelson.
(20) *P. gilliesi subfusca* Powell, 1930. Kaihoka, North side West Haven Inlet.
(21) *P. gilliesi montana* Powell, 1936. Southern section of Wakamarama Range, West Nelson.
(22) *P. gilliesi brunnea* Powell, 1938. North side of Paturau River near mouth, West Nelson.
(23) *P. gilliesi aurea* Powell, n. subsp. Mangarakau, North of Paturau River, West Nelson.
(24) *P. gilliesi kahurangica* Powell, 1936. Kahurangi Point, West Nelson.
(25) *P. jamesoni* Powell, 1936. Gouland Downs Track, West Nelson.
(26) *P. compta* Powell, 1930. The Castles, Eastern side Aorere Valley, West Nelson.
(27) *P. fallax* Powell, 1930. Ngarino and Onekaka Ridges, West Nelson.

(d) HOCHSTETTERI series.

(28) *P. hochstetteri* (Pfeiffer, 1862) Pikikiruna Range, Nelson.
(29) *P. hochstetteri anatokiensis* Powell, 1928. Western end of Tasman Range, West Nelson.
(30) *P. hochstetteri obscura* Beutler, 1901. Western Marlborough Sounds, D'Urville Island and Stephen Island.
(31) *P. hochstetteri consobrina* Powell, 1936. Mt. Duppa and area between Pelorus and Queen Charlotte Sounds.
(32) *P. hochstetteri bicolor* Powell, 1930. Eastern Marlborough Sounds.
(33) *P. marchanti* Powell, 1932. Ruahine Range.

(e) TRAVERSI series.

(34) *P. traversi* Powell, 1930. Levin, north of Wellington.
(35) *P. traversi koputaroa* n. subsp. Koputaroa to Manawatu (see Appendix).
(36) *P. traversi tararuaensis* Powell, 1938. Kaihinu, east of Tokomaru.
(37) *P. traversi florida* Powell, n. subsp. Foothills, Muhunoa East, south of Levin.
(38) *P. traversi otakia* Powell, n. subsp. Otaki, north of Wellington.

## Genus 3. **Wainuia Powell, 1930.**

(Type: HELIX URNULA Pfeiffer)

(1) *W. urnula* (Pfeiffer, 1855) Wellington; Tararua Range; Kapiti Island; Ruahine Range.
(2) *W. urnula nasuta* Powell, n. subsp. D'Urville Island.
(3) *W. edwardi* Suter, 1899) Hossack Downs, North Canterbury.
(4) *W. fallai* Powell, n. sp. Seaward Kaikoura Range.
(5) *W. clarki* Powell, 1936. Motutaiko Island, Lake Taupo.

## Genus 4. **Schizoglossa Hedley, 1902.**

(Type: DAUDEBARDIA NOVOSEELANDICA Pfieffer)

(1) *S. novoseelandica* (Pfieffer, 1862). North Island.
(2) *S. gigantea* Powell, 1930. Subfossil, cave near Tahora, Gisborne.
(3) *S. major* Powell, 1938. Subfossil, Pukemiro, Waikato.

## Genus 5. **Delos Hutton, 1904.**

(Type: ZONITES CORESIA Gray)

(1) *D. coresia* (Gray, 1850). North Island.
(2) *D. jeffreysiana* (Pfeiffer, 1853). North Island.

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## APPENDIX.

### Paryphanta traversi koputaroa n. subsp.

Additional information concerning the distribution of the *Paryphanta traversi* series resulted from a recent trip when a fortnight was spent with Messrs. R. A. and H. S. Prouse in the search for further colonies of snails.

An important discovery was a small colony of a low country form still persisting under adverse conditions in a small area of second growth native bush fringing a raupo swamp. The colony is situated on the Horowhenua Plain at approximately one and a half miles N.N.E. of Koputaroa Railway Station.

The Plain between Levin and the Manawatu River is now almost completely denuded of forest, the few small areas remaining being mostly low level kahikatea remnants subject to flooding and therefore without snails.

The Koputaroa snail represents a further new subspecies (AHPR of my table, see pp. 115-116), and its former distribution was probably over most of the northern part of the Horowhenua Plain from Koputaroa and Shannon to the Manawatu River.

Two specimens from the Charles Cooper collection, Auckland Museum, labelled "Manawatu," and a small series taken by a Mr. Gower in 1910 from near Koputaroa (site since cleared) are both AHPR. The base of the AHPR form is pale yellowish-citrine with very indistinct light-brown spiral lines and a central area of Mars-brown. This form is almost 100% pure at the new Koputaroa locality (about 2% are A-BLPR) and the basal-factor occurs in small percentages in several composite colonies to the north and north-east of Levin, i.e., Shannon Heights, CHPR 20% ; Park's Bush, Kawiu Road, Levin, CHPR 40% ; and Lake Papaitonga, N.E. corner, AHPR 10% (% probably much less if the series was larger).

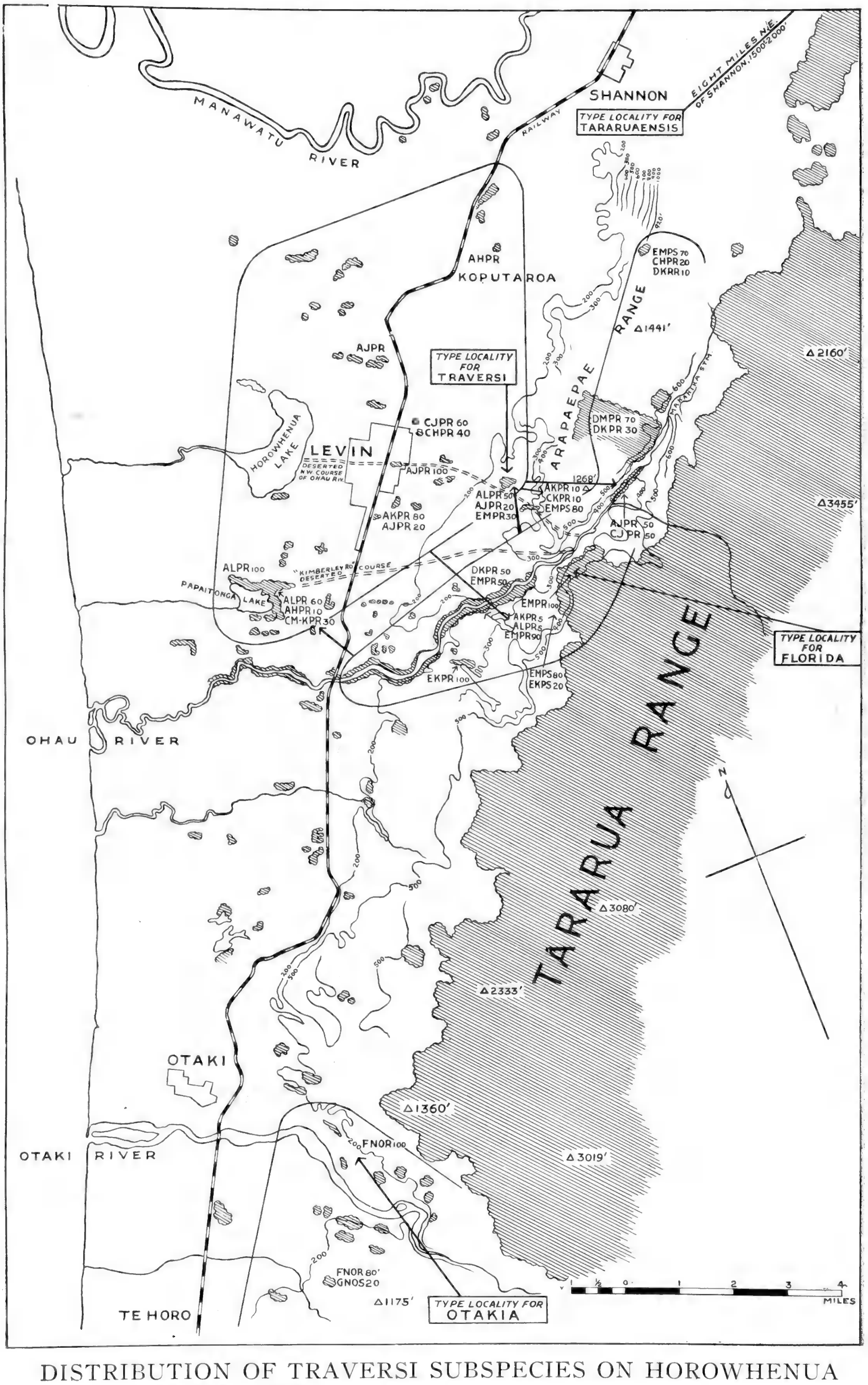
There has been no apparent topographic barrier between the typical Levin *traversi*, ALPR and the Koputaroa-Manawatu AHPR, but they are noticeably different at both the north and south extremes of the distributional area, although considerable integradation is apparent at intermediate locations. Extensive swamps probably exercised a partial segregating influence.

The high country *traversi tararuaensis*, BIQR is clearly a development from the AHPR Koputaroa-Manawatu form rather than from *traversi* typical ALPR.

Major diameter, 52.5 mm. Minimum diameter, 43 mm. Height, 27 mm. (holotype)

*Holotype:* Auckland Museum.

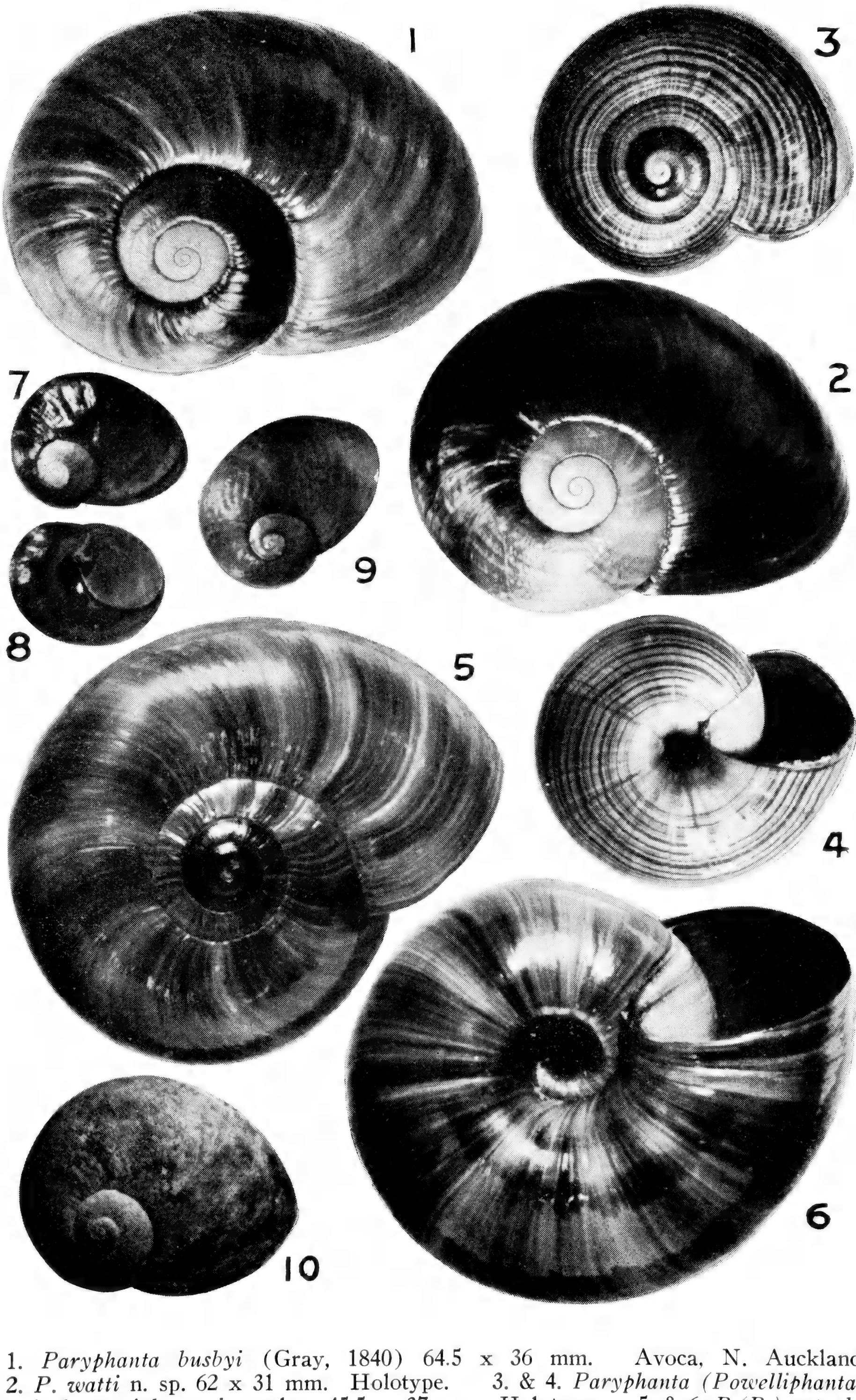
A figure will be provided in the next part of this series.



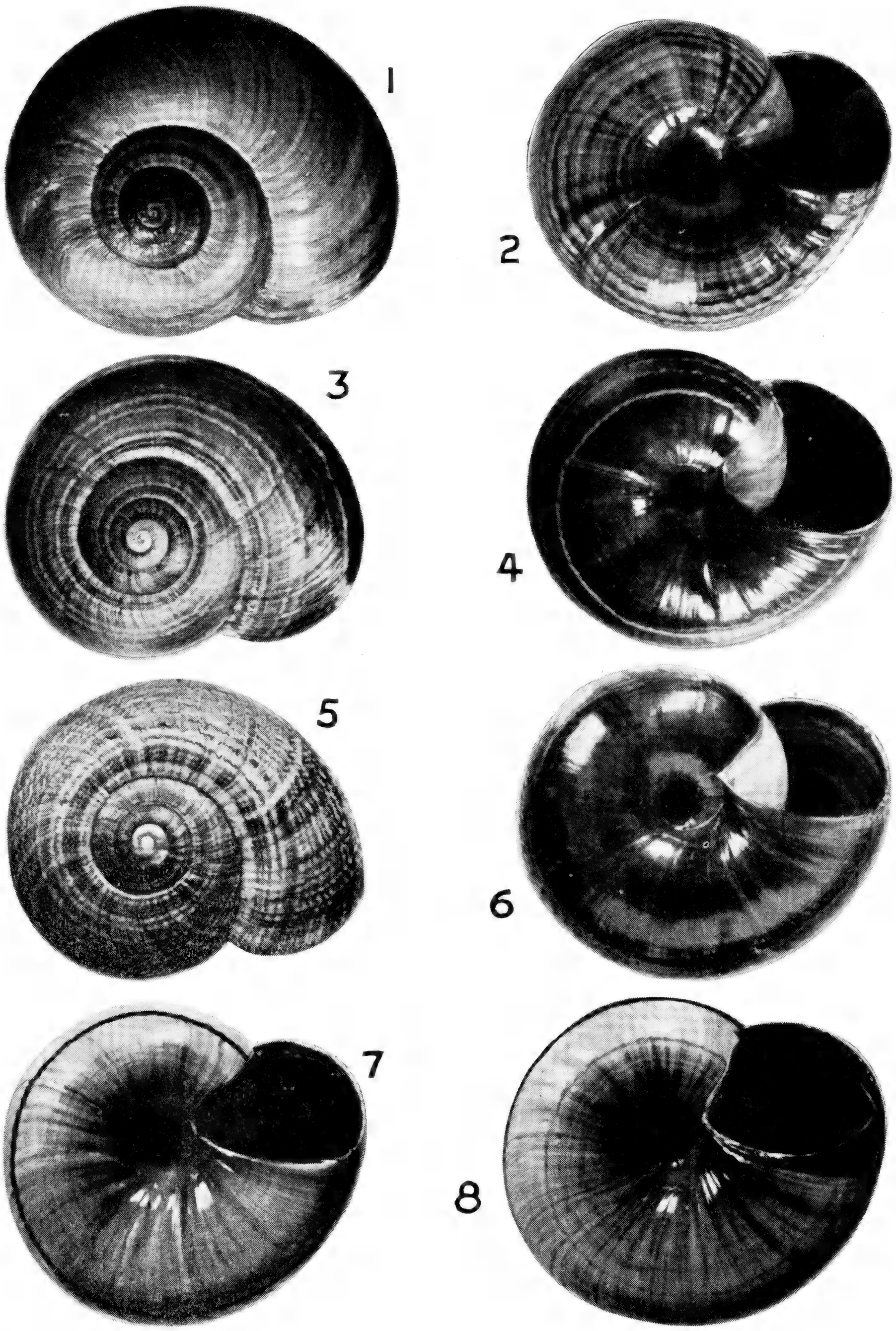

DISTRIBUTION OF TRAVERSI SUBSPECIES ON HOROWHENUA COASTAL PLAIN.

Showing type localities and areas of distribution for *traversi*, *florida* and *otakia*. The line shading represents native forest. The lettered symbols, i.e., ALPR, are explained in the text, and the numerals following these symbols are percentages. (See Appendix for description of *traversi koputaroa* AHPR.)

PLATE 9.




1. *Paryphanta busbyi* (Gray, 1840) 64.5 x 36 mm. Avoca, N. Auckland. 2. *P. watti* n. sp. 62 x 31 mm. Holotype. 3. & 4. *Paryphanta (Powelliphanta) unicolorata johnstoni* n. subsp. 45.5 x 37 mm. Holotype. 5. & 6. *P.(P.) superba harveyi* n. subsp. 64 x 54 mm. Holotype. 7. & 8. *Wainuia fallai* n. sp. 24.5 x 19 mm. Holotype (Fig. 7). 9. *W. urnula nasuta* n. subsp. 27.5 x 20 m.m. Paratype. 10. *Rhytida oconnori* n. sp. 20.75 x 16.5 mm. Holotype.




1. *Paryphanta (Powelliphanta) traversi* Powell, 1930. 52 x 43.5 mm. Lake Papaitonga, Levin. 2. *P. (P.) traversi* Powell, 1930. 48 x 40 mm. Holotype. 3. *P. (P.) traversi florida* n. subsp. 48.5 x 40 mm. Holotype. 4. *P. (P.) traversi florida* n. subsp. Paratype. 5. & 6. *P. (P.) traversi otakia* n. subsp. 48 x 39.5 mm. Holotype. 7. *P. (P.) gilliesi aurea* n. subsp. Paratype. 8. *P. (P.) gilliesi aurea* n. subsp. 50.5 x 43 mm. Holotype.

# New Species of New Zealand Mollusca from the South Island, Stewart Island, and Chatham Islands.

By A. W. B. POWELL, Acting-Director.

## Genus **ZEDILOMA** Finlay, 1926.

### Subgenus **FRACTARMILLA** Finlay, 1926.

Type (o.d.) : LABIO CORROSA A. Adams.

**Zediloma (Fractarmilla) corrosa zebrina** n. subsp. **Pl. 11, figs. 4 and 5.**

This is a very distinct and constant subspecies characterised by a bold radial zigzag pattern of dull black stripes on a cream ground. The shell is small compared with typical *corrosa*, more regularly conic and has considerably less expansion of the white basal callus-pad. In *corrosa* this pad extends to half the width of the base or even more, but in *zebrina* the spread covers little more than one-third of the diameter of the base. Radial stripes 12-15 on the body-whorl. Spiral sculpture subobsolete, 5 very faintly indicated cords on spire-whorls and 8-10 equally faint linear-spaced cords on the base. Outer lip with a broad yellowish margin heavily blotched with black at the terminal points of the radial stripes. Interior of aperture pale greenish to purplish iridescent.

Height, 12 mm.; diameter, 13.5 mm. (holotype).

Height, 17.4 mm.; diameter, 17.0 mm. (largest paratype).

*Holotype and Paratypes:* Auckland Museum.

*Locality:* Beach Harbour, Breaksea Sound, Western Otago, on rocks scattered on an intertidal mud-flat. (A.W.B.P., Nov., 1934.)

This subspecies is easily distinguished from the Eastern Otago zigzag striped form of *corrosa,* which has a name available in *Chlorostoma undulosum* A. Adams, 1853. However, I do not propose to recognise *undulosum*, even subspecifically, for all non-eroded examples of typical *corrosa* exhibit a zigzag pattern. The typical *corrosa* pattern consists of very numerous closely spaced narrow zigzag radial stripes, 32-33 on the body-whorl. In *zebrina* there is a maximum of 15 stripes, the average being 12. A large series was collected, showing it to be a very constant form.

Hutton's *Diloma plumbea* (1883, Trans. N.Z. Inst. 15, p. 126) is probably worthy of subspecific recognition. It is small, dull purplish to black with a very wide white parietal callus-pad and a simple black margining of the outer lip, without the yellow border. It is common at Sumner (type) and Lyttelton.

## Genus **MICRELENCHUS** Finlay, 1926.

Type (o.d.): TROCHUS SANGUINEUS Gray.

### **Micrelenchus parcipictus** n. sp. Pl. 11, fig. 1.

Shell turbinate-conic, openly umbilicated, solid; sculptured with distinct flat-topped spiral cords, five on spire-whorls, and thirteen on the body-whorl, including base. Interspaces linear on early whorls, increasing to twice width of cords towards the umbilicus. Spire obtusely conical, same height as aperture; periphery subangled; base convex. Umbilicus deep, open, in a smooth funnel-shaped area. Aperture subquadrate. Peristome discontinuous, columella much thickened, arcuate and partly overhanging the umbilicus; outer lip thin and corrugated by the spiral cords. Interior of aperture strongly lirate. Coloration variable; the holotype has a cream ground on the spire, which is radially banded and diffused with dark brown. Interior of aperture pale greenish iridescent. Some of the paratypes have the radial pattern on the first two post-nuclear whorls only, the rest of the shell being purplish to greenish gray indistinctly clouded with dull red or brown.

Height, 7 mm.; diameter, 7 mm.

*Holotype and paratypes:* Auckland Museum.

*Locality:* Sealer's Beach, between Otago's Retreat and Puysegur Point, South-West Otago, on under sides of stones at low tide. (A.W.B.P., Nov., 1934.)

The species is close to *tenebrosus* A. Adams, but is readily distinguished by the constantly open umbilicus, fewer spiral cords and radial colour pattern. In *tenebrosus* there are six or seven cords on the spire whorls, the umbilicus is callus-filled, except in young examples, and the coloration is uniformly purplish to greenish-grey with the spirals picked out in black; it is never radially colour banded.

I have records of *tenebrosus* from Stewart Island, Solander Island, Foveaux Strait, Dunedin Harbour, and Pukearuhe, North Taranaki. The latter is the furthest north locality I have been able to verify. The related *huttoni* is the common North Island species, which also occurs abundantly throughout the South Island, Stewart Island and the Chathams.

### **Micrelenchus oliveri** (Iredale, 1915) Pl. 11, fig. 8.

1884 *Cantharidus pupillus:* Hutton, P. Linn. Soc. N.S.W. 9, p. 362 (not a new name, but ascribed to Gould's *Trochus pupillus* from N.W. America).

1897 *Cantharidus pupillus:* Suter, Proc. Malac. Soc. Lond. 2, p. 270.

1913 *Cantharidus pupillus:* Suter, Man. N.Z. Mollusca, Govt. Printer, Wellington, p. 126. Atlas 1915, Pl. 33, f. 7.

1915 *Cantharidus oliveri* Iredale, Trans. N.Z. Inst. 47, p. 438, nom. nov. for "the species described by Suter under the name *Cantharidus pupillus* Hutton, 1884."

1937 *Micrelenchus oliveri:* Powell, The Shellfish of New Zealand, Unity Press, Auckland, Pl. 8, f. 6 (Mount Maunganui, Bay of Plenty).

Iredale renamed the species long accepted as *Cantharidus pupillus*, but unfortunately he did not nominate a type, nor did he cite a type locality. Hutton first used this combination, but did not describe *pupillus* as a new species. He merely borrowed Gould's name, *Trochus pupillus*, founded on a North West American shell, which is quite dissimilar, and is now known as *Pupillaria pupilla* (Gould, 1849). Suter

(1913, p. 126) cited localities as "Banks Peninsula to Dunedin (Captain Hutton); Hauraki Gulf; Manukau Heads; East Cape; Lyall Bay; Lyttelton and Akaroa Harbours; Bay of Islands," and stated "Type in the Canterbury Museum." Since Iredale's name is definitely based on Suter's 1913 interpretation, and Suter's figure is probably a North Island example, I now select as neotype a specimen in the Auckland Museum from Takapuna Reef, Hauraki Gulf. The Canterbury Museum specimen, even if labelled type of Hutton's *pupillus*, has no validity, as Hutton never formally proposed the name. Suter's figured example would make the best basis for the type of Iredale's species except for the fact that Suter did not indicate in his collection any of the examples figured in his atlas, nor did he indicate the localities of the specimens selected for illustration.

The necessity for fixing a type and type locality for *oliveri* is occasioned by the discovery of a distinct subspecies which shelters under the discs of the giant kelp *D'Urvillea*, and is distributed along the east coast of the South Island.

**Micrelenchus oliveri cryptus** n. subsp. Pl. 11, fig. 7.

Distinguished from the typical species by its turbinate shape, having a dome-shaped spire instead of a sharply conical one with straight outlines. The spiral cords are broader and less numerous, the peripheral angulation is almost obsolete, the coloration is much paler, the pattern less definite, and the whole shell is much stronger, the peristome being particularly massive. Typical *oliveri* has 6 to 7 flat-topped spirals with linear interstices on the spire-whorls and 8 on the base. The subspecies *cryptus* has 3 to 5 much broader flat-topped spirals on the spire-whorls but still with linear interstices, while on the base there are 5-6 broad, flattened spirals with interstices up to half the width of the spirals. Frequently the two uppermost spirals of the spire-whorls are fused into one broad bulge which renders the whorls distinctly shouldered. Coloration of holotype pale purplish-grey, with the early whorls regularly tessellated with rose. Peristome dull creamy-white, interior of aperture pale greenish iridescent. All other examples are similarly coloured except that the rose markings sometimes appear as broad radiate flames on the early whorls and in others the tessellate pattern persists over the whole shell.

The coloration of typical *oliveri* is dull green, regularly tessellated with red, interior of aperture brilliant greenish iridescent. This pattern is very constant in examples from Takapuna, where the species is common in seaweeds at low tide, together with *M. dilatatus*. At Mount Maunganui and many other northern localities of the open coast examples with broad scarlet flames on a pink ground are common.

Height, 9 mm.; diameter, 9 mm. (Holotype of *o. cryptus*)

Height, 8 mm.; diameter, 6.75 mm. (Neotype of *oliveri*)

*Holotype and Paratypes.:* Auckland Museum.

*Localities:* Kakanui and Kartigi, North Otago; 4 miles south of Clarence River, Marlborough (type), Goose Bay, Kaikoura (A.W.B.P., Jan., 1928). Good series were taken, all from beneath the holdfasts of the giant kelp *D'Urvillea.*

The locality range of typical *oliveri* is at least Cape Maria van Diemen to Lyttelton. Since Lyttelton examples are quite typical, *cryptus* cannot be considered a regional subspecies, but is a constant subspecific form restricted in station to the kelp holdfasts. Other shellfish which are restricted to kelp holdfasts are *Margarella decepta* Iredale and *Frembleya egregia* H. Adams.

## Genus **MAUREA** Oliver, 1926

Type (o.d.): TROCHUS TIGRIS Martyn.

### **Maurea pellucida morioria** n. subsp. Pl. 11, fig. 3.

Chatham Islands examples of *pellucida* differ constantly from the mainland typical species in being more broadly conic, with almost straight spire outlines. The spire-whorls are almost flat, not indented at the sutures; the periphery is broadly rounded and the base strongly convex. The spire angle for *morioria* is 82 degrees, but only 74 degrees for the typical species. The sculpture and the colour pattern are identical in both species and subspecies.

| | | | | | |
|---|---|---|---|---|---|
| Height, | 39 mm.; | diameter, | 41 mm. | (holotype of *morioria*) | |
| „ | 34 „ | „ | 36 „ | (paratype „ | „ ) |
| „ | 28 „ | „ | 32 „ | ( „ „ | „ ) |
| „ | 35 „ | „ | 35 „ | (*pellucida*) | |
| „ | 30 „ | „ | 30 „ | ( „ ) | |
| „ | 28 „ | „ | 26 „ | ( „ ) | |

*Locality:* Owenga Beach, Chatham Islands (24 examples).

*Holotype and Paratypes:* Auckland Museum (collected, A.W.B.P., 1937).

## Genus **LISSOTESTA** Iredale, 1915.

Type (o.d.): CYCLOSTREMA MICRA Ten. Woods.

The shells at present grouped under *Lissotesta* are not all congeneric. I have used the genus as a convenient location for small Trochoids of uncertain affinity, but I now propose to remove three of the species to a new genus:—

## **LISSOTESTELLA** n. gen.

Type: LISSOTESTA TENUILIRATA Powell.

This new genus resembles *Lissotesta* in shape, but it is of more solid texture. The surface, instead of being polished, is dull and regularly spirally lirate. In *Lissotesta* the peristome is thin and not continuous. That of the new genus is continued across the parietal wall, and is strengthened on the outside by a broad low varix. Inside the aperture there is a slight rim or ledge which suggests the presence of a stout operculum—possibly a calcareous one, and, if this should prove to be the case, removal of the genus to the vicinity of *Argolista* may be necessary. The protoconch is of one whorl and is larger and more globose than in *Lissotesta*.

In addition to the genotype, *L. rissoaformis* and *L. tryphenensis*, both of Powell, 1931, are congeneric.

The typical members of *Lissotesta* are *errata* Finlay, 1926; *granum* (Murdoch and Suter, 1906); *benthicola* Powell, 1927, and *decipiens* Powell, 1940. The remainder are separable into five groups, but I do not propose to name them until more species of each group are located and better diagnostic characters are apparent. The groups are (1) *caelata* Powell, 1937, and *consobrina* Powell, 1940, strongly spirally keeled forms; (2) *conoidea* Powell, 1937, elevated and narrowly conical; (3) *oblata* Powell, 1940, globose but with flattened spire; (4) *aupouria* Powell, 1937, globose, widely umbilicated, with a free D-shaped aperture; (5) *bicarinata* Powell, 1940, trochiform with keeled body-whorl and a subsidiary crenulated keel on the base.

## Genus **BADENIA** Finlay, 1930.

(nom. nov. for *Powellia* Finlay, 1926, non. Maskell, 1879)

Type (o.d.): Powellia lactea Finlay.

In describing *Haurakia duplicata* and *H. duplicata exuta,* both from 260 metres off the Three Kings Islands (Powell, 1937, Discovery Reports, Vol. 15, p. 191) I failed to realise their close affinity with *Powellia paupereques* Finlay, 1926, from the Poor Knights Islands in 60 fathoms (Finlay, 1926, Trans. N.Z. Inst. Vol. 57, p. 404). Finlay's *Powellia paupereques* is very close to my *Haurakia duplicata exuta* but is specifically distinct, for it has a much weaker peripheral thread and numerous subobsolete axials. In *exuta* there are no axials, but typical *duplicata* has strong distant axials. Both have a more dilated aperture than *paupereques.*

The family location of *Badenia* is still in doubt, since neither the animal nor the operculum is known, but it may continue to rest in the *Rissoidae* where it was placed originally by Finlay. The vitreous appearance of these shells suggests the *Eulimidae,* and Finlay (1930, Trans. N.Z. Inst. 61, p. 41) has already advocated the removal of his genus to this family. Still another possibility is in the *Rissoinidae* near *Zebina.*

## Genus **COMINELLA** H. and A. Adams, 1853.

## Subgenus **EUCOMINIA** Finlay, 1926.

Type (o.d.): Buccinum nassoides Reeve.

Finlay (1928, Trans. N.Z. Inst. Vol. 59, pp. 255-256) has already noted the occurrence of well-defined races of *nassoides.* He described one of them, *iredalei,* the broad, squat species from Chatham Islands, advocated the use of *nodicincta* v. Martens for one Subantarctic Islands form and stated the probability of a further Subantarctic member in Filhol's *Buccinum veneris* (= *filholi* Finlay, 1930) from Campbell Island. Finlay also mentioned the occurrence of two benthic species from eastern Otago, one from 20-60 fath. off Otago Heads and the other from 50 fathoms off Oamaru.

Stewart Island shallow water examples are the true *nassoides.* They have a long narrow aperture and on the spire-whorls three strong spiral ribs in addition to the sutural fold, all nodulose where they cross

the axials. Deeper water examples from Stewart Island and Foveaux Strait in 15 fathoms have a shorter aperture, are much smaller, the spiral cords weaker, and the axials resolve into 3 to 2 rows of rounded nodules. These are *nassoides foveauxana* n. subsp.

I now propose to name the benthic Otago Heads species *otakauica* n. sp. These have a proportionately smaller, more rounded aperture and five spiral cords on the spire-whorls. The benthic Oamaru shells are similar in their early stages but the axials become obsolescent over the last two whorls. More material is required to determine the status of this form, which is known to me by only three examples.

Finlay's Chalky Inlet specimens classified by him as *nassoides* are very distinct and are here named *haroldi* n. sp. They have three rows of nodules but no spiral cords on the spire whorls and a dense minutely striated surface.

Still another new species, *marlboroughensis*, from 70 fathoms off Cape Campbell, is very close to the Upper Pliocene (Castlecliffian), *elegantula verrucosa* Finlay, 1926, and it makes a considerable northern extension to the known range of the genus (see note under this species. It may not be of recent occurrence).

**Cominella (Eucominia) nassoides foveauxana** n. subsp. **Pl. 12, figs. 3 and 4.**

This deep water form of *nassoides* is little more than half the size of the typical shore species. It has a relatively wider aperture, shorter body-whorl and weak to subobsolete spiral cords. On the spire-whorls the axials rapidly resolve into three spiral rows of bluntly rounded nodules, one subsutural, another peripheral, and the third below. There are 15 to 17 nodules in a spiral series per whorl. On the body-whorl only the subsutural and peripheral nodules persist. Inside of outer lip without lirations.

| | | | | |
|---|---|---|---|---|
| Height, | 36.75 mm. | Diameter, | 18.0 mm. | (holotype of *foveauxana*) |
| ,, | 31. 0 mm. | ,, | 16.0 mm. | (*foveauxana*) |
| ,, | 49. 0 mm. | ,, | 23.5 mm. | (*nassoides*, Stewart Island) |
| ,, | 46. 5 mm. | ,, | 22.5 mm. | ( ,, ,, ,, ) |

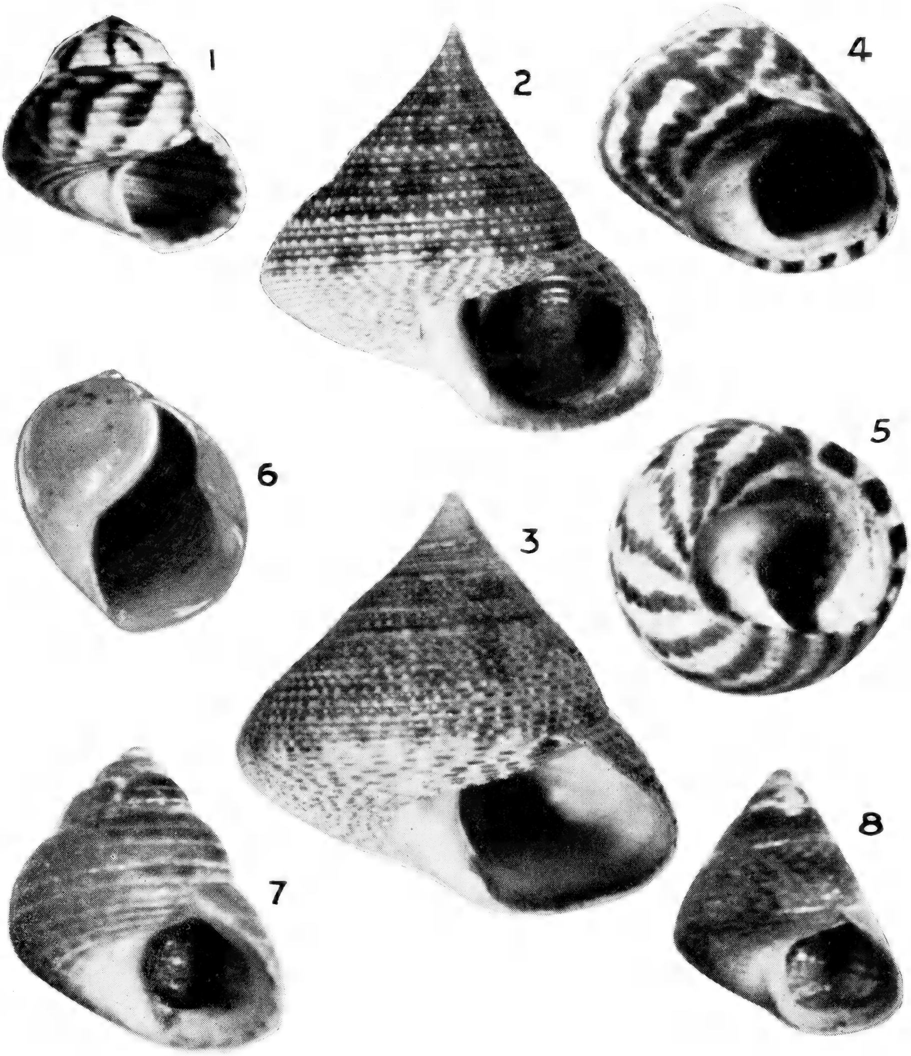
*Holotype:* Charles Cooper collection, Auckland Museum.

*Localities:* Foveaux Strait (type); Foveaux Strait, 15 fathoms (Finlay collection, Auckland Museum); Foveaux Strait, from oyster dredgings (A. C. O'Connor).

The type locality for typical *nassoides* is here designated as Ringaringa, Stewart Island.

**Cominella (Eucominia) haroldi** n. sp. **Pl. 12, figs. 8 and 9.**

This species is related to *nassoides* but is a squat form nearer in proportions to the Chatham Island *iredalei*. It has broadly rounded axials, sixteen on penultimate whorl, extending over most of the base, and these are rendered strongly nodulous both on the subsutural fold and at the shoulder. A very weak third row of nodules emerges at the suture on the body-whorl. The whole surface is crowded with delicate




1. *Micrelenchus parcipictus* n. sp. 7 x 7 mm. Holotype. 2. *Maurea pellucida* Valenciennes. 37.5 x 37 mm. North Head, Auckland. 3. *Maurea pellucida morioria* n. subsp. 39 x 41 mm. Holotype. 4. & 5. *Zediloma (Fractarmilla) corrosa zebrina* n. subsp. 12 x 13.5 mm. Holotype (Fig. 5) and Paratype. 6. *Mysticoncha harrisonae* n. sp. 21.5 x 18.5 mm. Holotype. 7. *Micrelenchus oliveri cryptus* n. subsp. 9 x 9 mm. Holotype. 8. *M. oliveri* (Iredale, 1915) 8 x 6.75 mm. Neotype. Takapuna Reef, Auckland.

wavy spiral striations, about ten per millimeter. Subobsolete, distant, low spiral cords appear over the lower half of the base only. Spire about three-fourths height of aperture. Colour creamy-white, with a faint pattern of pale rusty brown streaks between the axials and five very obscure spiral bands on the body-whorl. The uppermost band is in the interstices of the subsutural nodules.

Height, 33 mm.; diameter, 18 mm.; spire, 15 mm.

*Locality:* Chalky Inlet, South-West Otago.

*Holotype:* Collection of Dr. Harold J. Finlay, Auckland Museum.

The species is easily distinguished by the uniform dense spiral striations and absence of spiral cords on the spire-whorls.

### **Cominella (Eucominia) otakauica** n. sp. Pl. 12, figs. 5-7.

This and the following species differ from *nassoides* in having a proportionately smaller and more rounded aperture. In *nassoides* the aperture is always narrowly ovate—height 25 mm.; breadth 15 mm. (edge of outer lip to outer expansion of parietal callus). Similar measurements of *otakauica* are height 20 mm.; breadth 14 mm. Another differentiating feature is in the primary spiral cords of the spire-whorls —*nassoides* has three strong cords, but there are five in *otakauica*.

Shell large, with same proportion of diameter to height as in *nassoides*, but the spire is relatively much taller, being 1.3 times height of aperture. In *nassoides* the spire is less than the height of the aperture. The primary spirals, that is, in addition to the nodular sutural folds, commence at four and increase to five at the end of the penultimate. The secondary spiral sculpture consists of 10-12 lirations from the suture to the shoulder angle, a single lirae between each pair of primary spirals on the spire but increasing to five on the base. Axials thirteen per whorl, persistent over body-whorl. The inside of the outer lip is never lirate, but in typical shallow-water *nassoides* lirations are invariably present. Colour buff diffused with rusty-brown.

Height, 45 mm.; diameter, 21 mm.

*Localities:* Off Otago Heads; 20 fath. and 40-60 fath. (type from 60 fath.).

*Holotype:* Finlay collection, Auckland Museum.

Three examples from 18 miles E.S.E. of Oamaru in 50 fathoms have the axials obsolete on the body-whorl. Further material may reveal this as another regional species.

### **Cominella (Eucominia) marlboroughensis** n. sp. Pl. 12, fig. 10.

This is a much smaller and thinner shell than *nassoides*, being very similar to the Upper Pliocene (Castlecliffian) *elegantula verrucosa* Finlay, 1926. It differs from the Castlecliffian species in having a proportionately taller spire and more slender axials. Spire 1.3 times height of aperture. The spire is equal to the height of the aperture in *verrucosa*. Axials slender, fourteen per whorl, subobsolete on the deeply concave shoulder, but strongly nodulous on the subsutural bulge. Spiral

sculpture of weak cords, 8 on spire-whorls and a few distantly spaced on the lower half of the body-whorl; the whole shell is covered with dense fine lirations. Aperture ovate, not lirate within.

Height, 29.25 mm.; diameter, 13.4 mm.

*Locality:* Thirty miles south of Wellington and 25 miles east of Cape Campbell, 70 fathoms.

*Holotype:* Powell collection, Auckland Museum.

The only example is dull white and leached, in common with all other shells from this dredging which may be a wash from some submerged Pliocene bed.

## Genus **MYSTICONCHA** Allan, 1936.

Type (o.d.): LAMELLARIA WILSONI Smith.

### **Mysticoncha harrisonae** n. sp. **Pl. 11, fig. 6.**

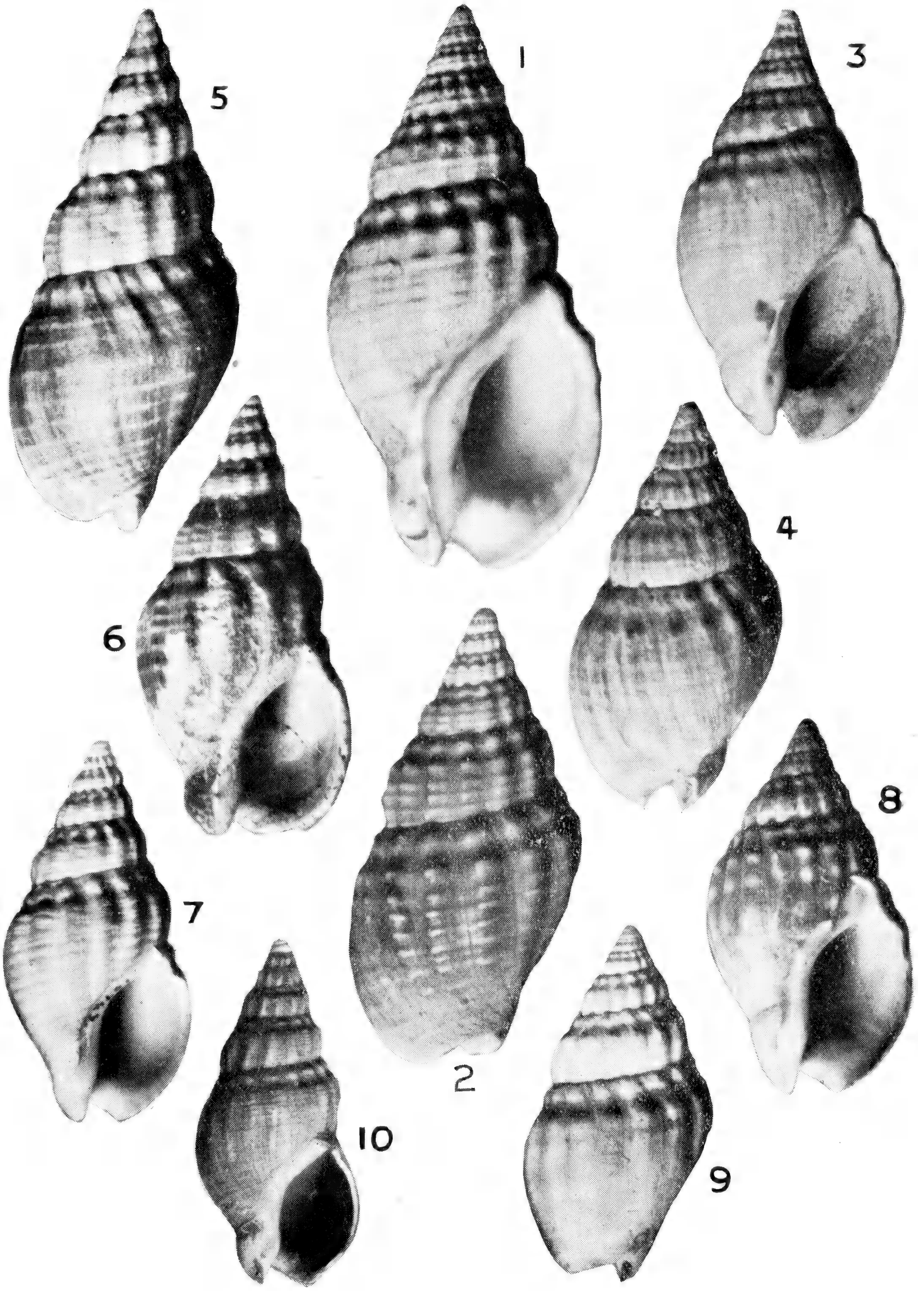
Shell moderately large, globose-ovate with a large aperture and few whorls; very thin, semi-transparent, white. Whorls 3½ including the protoconch of one whorl, which is slightly convex and eroded in the only known specimen. The protoconch and the following whorl form a dome-shaped protuberance from the ovate outline of the rest of the shell. Suture deeply impressed. Outer lip very thin, membranous at the extreme edge, and produced forward above the middle in a broad curve. Basal part of lip broadly concave. Columella slightly thickened, concave and flexuous. Parietal wall without callus. Sculpture of closely spaced fine axial growth lines which show the successive stages of the basal-lip concavity in a spiral contour running parallel to the columella and entering the aperture on the lower curve of the parietal area.

Height, 21.5 mm.; diameter, 18.5 mm.

*Locality:* Lowrie's Beach, The Neck, Stewart Island (collected, Mrs. R. H. Harrison).

*Holotype:* (unique), an empty shell, Powell collection, Auckland Museum.

This makes an interesting new generic record for New Zealand. Previously *Mysticoncha* was known only from Victoria and South Australia. Living examples of the Australian genotype show the shell to be completely internal in an oval animal conspicuously marked with a geometric pattern of six-sided figures in dark brown.




1. & 2. *Cominella (Eucominia) nassoides* (Reeve, 1846) 46.5 x 22.5 mm. Ringaringa, Stewart Island. 3. & 4. *C. (E.) nassoides foveauxana* n. subsp. 36.75 x 18 mm. Holotype (Fig. 3). 5. & 6. *C. (E.) otakauica* n. sp. 45 x 21 mm. Holotype (Fig. 5). 7. *C. (E.) otakauica* n. sp. 40-50 fath. Otago Heads. 8. & 9. *C. (E.) haroldi* n. sp. 33 x 18 mm. Holotype (Fig. 8). 10. *C. (E.) marlboroughensis* n. sp. 29.25 x 13.4 mm.

# RECORDS

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# CONTENTS

Vol. 3, No. 3.

# A Giant Heart-urchin
## *Brissus gigas n. sp.*
## From NEW ZEALAND

By H. BARRACLOUGH FELL,

Victoria University College, Wellington.

The giant heart-urchin which is the subject of this paper was taken in deep water off the Bay of Islands and is now preserved in the collection of the Auckland Museum. It is evidently an undescribed species exceeding in size any echinoid hitherto known from New Zealand waters. As set out in the discussion below, there are grounds for believing that the specimen may ultimately become the type of a new genus, but in the meantime owing to the paucity of material it has been deemed advisable to place it in the genus *Brissus*, with which it most closely agrees.

The large size of the specimen has necessitated considerable reduction of the photographic figures. As the ornamentation and other surface features o, fthe test are relatively unaccentuated, and consequently difficult to photograph, the location of the chief features shown on Plates 13 and 14 may be indicated here before proceeding to the diagnosis. On the abactinal aspect the peripetalous fasciole, which in life would carry a band of ciliary radioles, may be discerned following a zig-zag course, enclosing the lateral and posterior pairs of petaloid ambulacra, curving sharply inwards in the intervening interambs, and tracing a broad convex sweep across the anterior part of the test. On the actinal side the large sternal plastron of the posterior interamb is delineated by its dark border, and occupies all the medial region posterior to the peristome. The sub-anal plastron, lying between the sternal plastron and the periproct, is foreshortened in this aspect, but the sub-anal fasciole by which it is circumscribed can be discerned. The latter structures are shown in full view in Text Figure 2, while Figure 1 gives details of the apical region.

### Genus **BRISSUS** Leske, 1778.

Peripetalous fasciole present, but no internal nor anal fascioles; petals well formed and depressed; sub-anal fasciole complete, surrounding a distinct sub-anal plastron.

**Brissus gigas** n. sp. Plates 13 and 14; Text Figures 1 and 2.

*Diagnosis:* Test very large and inflated, without anterior notch, broadly ovate, truncate posteriorly. Apex and peristome markedly praecentral; the periproct situated on the obliquely truncate postero-ventral border of the test. Petals I, II, IV and V narrow and deeply sunken, as wide as deep. Ambulacrum III flush with test. Interambulacrum 5

keeled obliquely above, posterior to the peripetalous fasciole, and less markedly so below the sub-anal fasciole. Sternal plastron showing traces of radial fan-like furrowing and a radial arrangement of the fine tubercles on it. Primary tubercles extending within the peripetalous fasciole in interambulacra 2 and 3.

Length, 185 mm. Breadth at level of apex, 145 mm. Greatest breadth (at level of posterior extremities of petals I and V), 167 mm. Height from apex to labrum, 90 mm. Greatest height (from a point midway between apex and posterior ambitus), 100 mm.

*Locality:* Off Bay of Islands, North Auckland, New Zealand.

*Depth:* Not recorded; stated to be from "deep water." Fragments of what may be the same species have been taken at Pt. Abercrombie, Gt. Barrier Island, from an estimated depth of ca. 20 metres.

*Holotype:* In the Auckland Museum.

The specific name proposed refers to the large size of the spatangoid.

## Fuller Account.

In view of the systematic problems raised by this specimen, a fuller account follows.

The material comprises a solitary denuded test, bleached to a pale creamy colour except within the peripetalous fasciole and in interambulacra 2 and 3, which are pale greyish. When collected the test was enveloped in a coralline alga, so that it is evident that the animal had been dead for some time. No trace could be found of any adhering radioles.

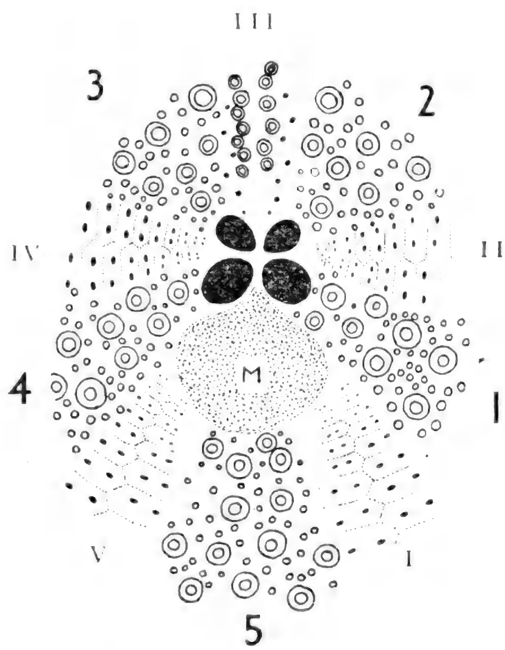



Fig. 1. Apical region. M., madrepore; I-V, Ambulacral columns; 1-5, Interambulacral columns, x 2.5.

The tuberculation extends over the whole of the interambulacral regions, but interambulacra 2 and 3 are distinguished both within and without the peripetalous fasciole by possessing larger primary tubercles. Only the primary tubercles are perforate.

The apical region (Fig. 1) is rather obscure owing to the intercalary deposition of calcite having masked the outlines of the plates. There are four gonopores, the posterior pair (in interambulacra 1 and 4) being larger and more widely separated than the anterior pair (in interambulacra 2 and 3). Ocular plates are indistinguishable and no ocular apertures can be seen. The madrepore in interambulacrum 5 is relatively large, broadly elliptical with an adapical acute angle between gonopores 2 and 5, and separates petals I and V, which are therefore not confluent proximally.

The peristome, which is anteriorly placed, below the apical region, presents a transverse crescentic outline when viewed from below, the anterior border being convex; breadth, 34 mm. The mouth, as usual, is directed antero-ventrally owing to the ventral displacement of the labrum.

The periproct is elliptical, situated on the obliquely truncate postero-ventral border of the test, below the ambitus, length 26 mm., breadth 20 mm.

The peripetalous fasciole is typical of Brissids.

The sub-anal fasciole is complete, surrounding a broadly reniform sub-anal plastron. There is no trace of an anal fasciole. As this arrangement is of generic significance, the region of the periproct is shown in Fig. 2. Breadth of sub-anal plastron, 75 mm., height at centre 27 mm.

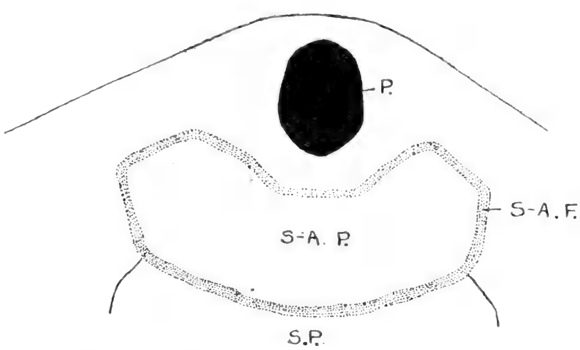



Fig. 2. Region of periproct. P., periproct; S-A.F., Sub-anal fasciole; S-A.P., Sub-anal plastron; S.P., Sternal plastron, x .5.

The sternal plastron is in the form of an isosceles triangle, the base of which is slightly concave and formed by the ventral border of the sub-anal fasciole, and the sides are convex where they border ambulacra I and V, while the apex is truncated by the labrum. The sternum is very obliquely keeled, and is remarkable for showing distinct traces of the radial fan-like furrowing characteristic of the genus *Metalia.* Length 104 mm., greatest breadth (midway along its length), 95 mm.; breadth at base, 65 mm.

Posterior petals, I and V, distinct, not confluent at any point, commencing on either side of the madrepore, and extending postero-laterally half the distance to the ambitus; 75 mm. long, deeply sunken (maximum depth 8 mm.), narrow (maximum width 8 mm.), bearing 40 distinct pairs of pore-pairs, all (except the adapical 3 or 4) approximately equally spaced. There are in addition signs of approximately three obsolete pairs at the proximal end of each petal.

Anterior petals, II and IV, deeply sunken (maximum depth 7 mm.), narrow (maximum width 7 mm.), the proximal two-thirds of each petal directed very slightly posteriorly, so as to form an obtuse angle with ambulacrum III. The distal one-third of each petal curves slightly anteriorly. Length of each petal 70 mm., extending seven-tenths of the meridional distance from the apex to the ambitus. There are 36 distinct pairs of pore-pairs, but as there are approximately five more obsolete proximal sets, the total will be about 41 for each petal.

The anterior ambulacrum III is for the most part flush with the test, save at the ventral extremity near the peristome. There are 32 pairs of solitary pores, some obsolete. The ambulacrum bears a median groove, 2 mm. wide, bordered on either side by a double or triple line of secondary tubercles, so that in general structure it resembles a fasciole; and perhaps performs a ciliary feeding function since it leads directly to the mouth. This ambulacrum is obsolete over a short distance below the fasciole, save for a few pores. The fasciole cuts it some 25 mm. above the ambitus, i.e., approximately two-thirds of the meridional distance along the ambulacrum from the apex to the ambitus. The obsolete section of the ambulacrum is responsible for the absence of an anterior notch from the ambitus.

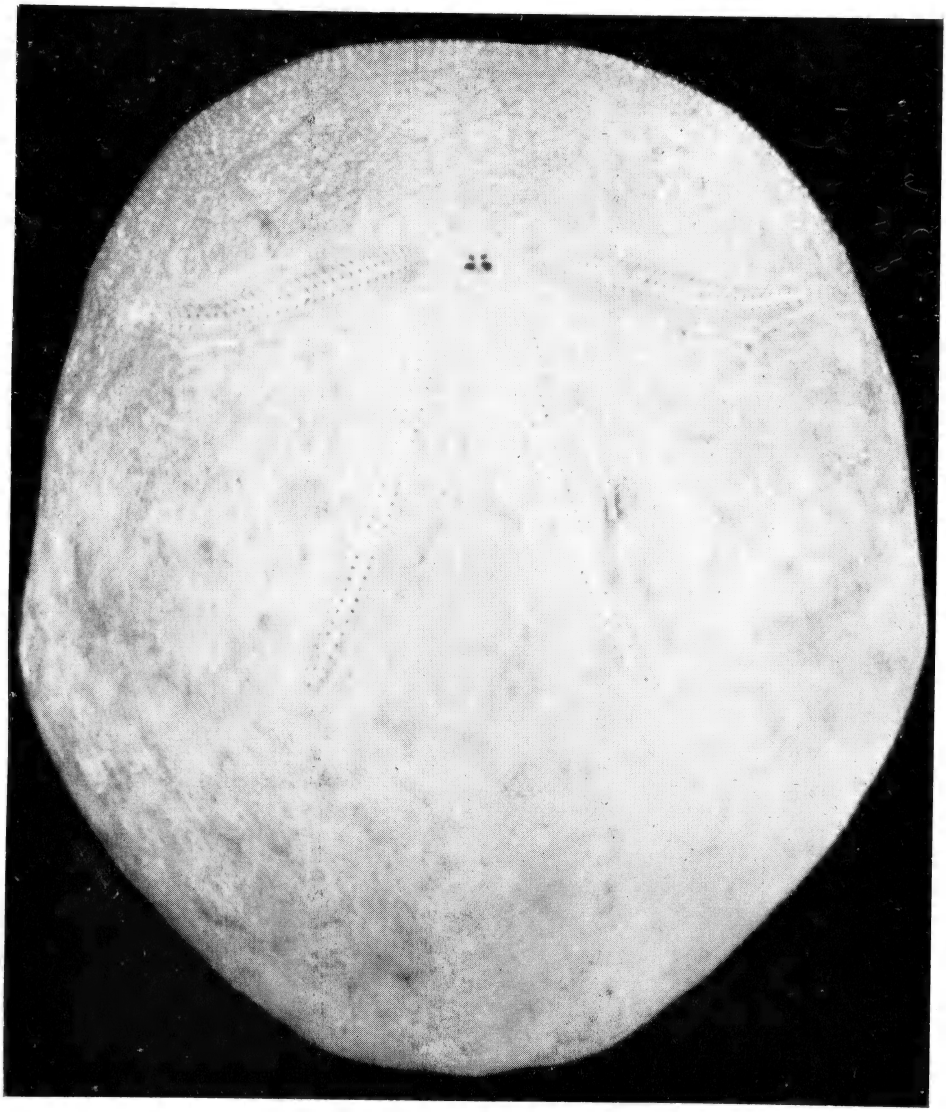
There is nothing remarkable about any of the interambulacra, save the dorsal and ventral keel of interambulacrum 5, already described.

## Systematic Position of Brissus gigas.

It can be seen that the characters of the species so far as can be determined from the test are in accordance with the diagnosis of *Brissus*, quoted above (from H. L. Clark, 1925). The only unexpected feature is the very large size.

On the other hand, if the species is assigned to *Brissus*, some anomaly results from the fact that others of its characters accord better with the genera *Metalia* and *Meoma*.

In a private communication Dr. Th. Mortensen, of Copenhagen, remarks on the general resemblance of the animal to *Metalia*, a genus which sometimes reaches a size approaching that of the present example. Both Ludwig (1904) and Tenison-Woods (1878) have drawn attention to the radial furrowing of the sternum in *Metalia*. The former gives it as the sole distinguishing feature from *Brissus*; but as now recognized, *Metalia* is also characterised by possessing anal fascioles. The latter are lacking in *B. gigas*, and as Mortensen regards this as an important diagnostic feature, it does not seem advisable to place the species in *Metalia*. According to H. L. Clark (1925) a diagnostic feature of *Metalia* is the absence of large primary tubercles from within the peri-



*Brissus gigas* n. sp. Abactinal view of test × 3/5.

petalous fasciole. *B. gigas* possesses such tubercles, which would also argue against placing it in *Metalia.* On the other hand, Tenison-Woods (1878) has recorded that the Australian species of *Metalia* possess the common feature "tuberculation within the peripetalous fasciole coarse, frequently consisting of primary tubercles." Owing to lack of material it is not possible for the writer to check these discordant statements. According to Jackson (1912) *Metalia* is notable in having both the primary and secondary tubercles perforate. *B. gigas* has only the primary tubercles perforate. Thus the main part of the evidence seems to weigh against assigning the species to *Metalia,* with which in general form, size and furrowing of the plastron it otherwise shows agreement.

The genus *Meoma* possesses a test of size and form comparable to *B. gigas,* and has similarly sunken petals. In this case disagreement occurs in the structure of the sub-anal fasciole, which is complete in *B. gigas,* whereas the diagnosis of *Meoma* given by H. L. Clark (1925) states that the sub-anal fasciole is imperfect, so that there is no well-marked sub-anal plastron. The anal fascioles are absent in *Meoma,* a point in respect of which *B. gigas, Brissus* s. s. and *Meoma* all correspond.

Owing to the fact that only the one test is available the species is recorded here under *Brissus.* When more material is obtained it will be possible to see how far the characters of the type specimen are normal ones and to what extent individual variation is involved; the characters of the exoskeleton and internal organs will also have an important bearing. If the characters described above prove to be constant, then it may be preferable to erect a separate genus, the characters of which would probably include the following:—

Test large, wide and inflated, without anterior notch; Peripetalous fasciole and sub-anal fasciole present, but no anal fasciole. Petals well formed and depressed. Sub-anal plastron wide, reniform. Sternal plastron large, bearing radiating fan-like furrows arising from the posterior margin. Primary tubercles extending within the peripetalous fasciole, and only the primary tubercles perforate.

Whether this combination of characters distinctive of various genera indicates a primitive condition or a case of convergence it is not possible at present to say. The large size would seem to count against the possibility of *B. gigas* being a primitive form.

## Acknowledgment.

I am indebted to Mr. A. W. B. Powell for the opportunity of reporting on this specimen; and to Dr. Th. Mortensen, of the Copenhagen Museum, who kindly gave his opinion on the generic problem involved.

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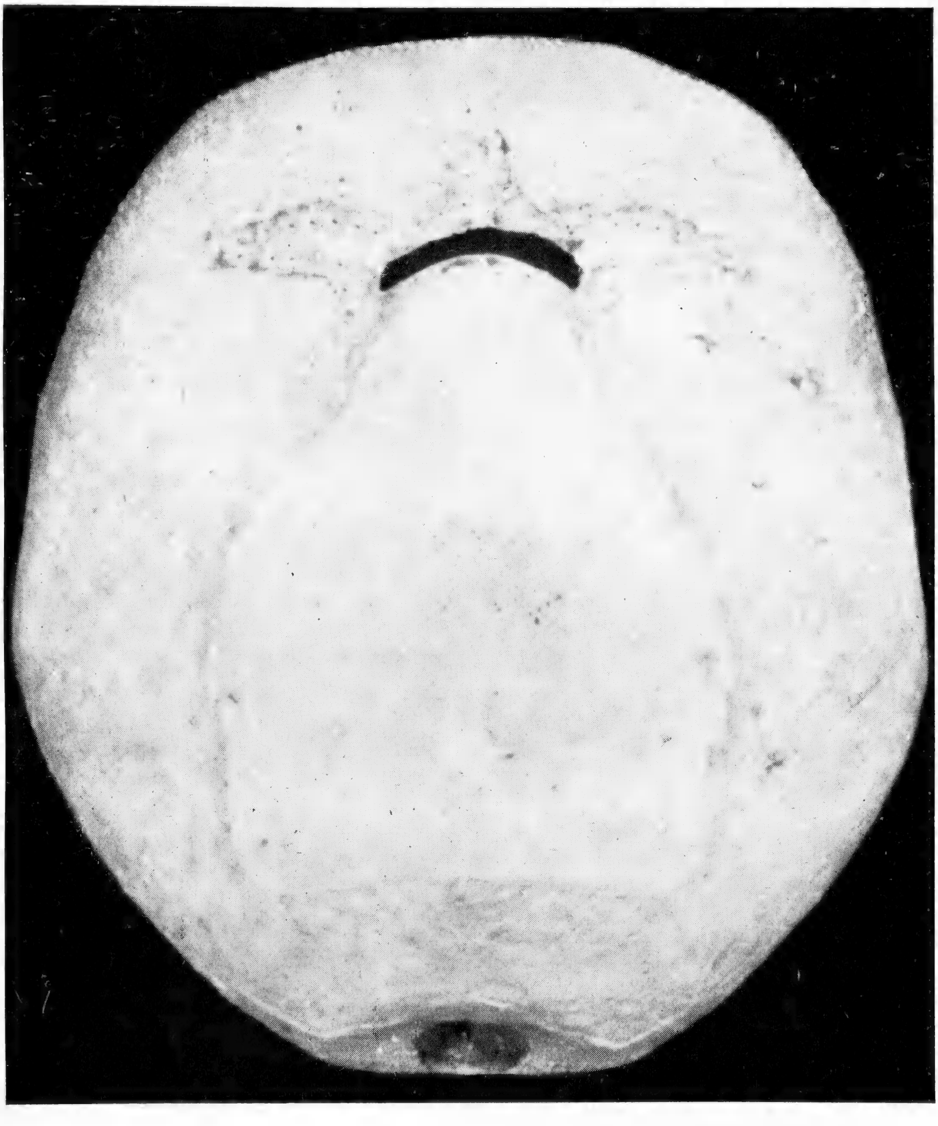

*Brissus gigas* n. sp. Actinal view of test x 3/5.

# Hair Cordage in Oceania

By OLWYN M. TURBOTT, Associate Ethnologist.

Long, relatively straight hair, one of the characteristic physical features of the Polynesians, has given rise to a small but significant element in their material culture. Human hair, braided into remarkably fine and even cordage, is used throughout Polynesia and in parts of Micronesia. Its use in Melanesia is restricted to such Polynesian outliers as Sikiana, Tikopia and Rennell, and the Southern New Hebrides, where Polynesian affinities are recognizable.

It should be noted that while hair is used in ornaments throughout Oceania, this paper refers only to its use in cordage, which implies plaiting or rolling.

The technique of making hair cordage is characterised by a considerable degree of uniformity throughout its geographical range in Oceania. It is generally a simple three-ply plait, made up with great neatness and regularity.

The articles made from this cordage fall into a few well-defined types. They are (1) personal ornaments; (2) cordage for decorative lashing; (3) fishing lines.

While the articles made from cordage in most islands are thus clearly defined, small local variations in detail are recognizable.

## 1.—PERSONAL ORNAMENTS.

### GIRDLES.

Girdles made of many strands of thin hair cord occur in several groups. They were usually worn by men and apparently indicated the rank and wealth of the wearer.

**Niue.** The wonderfully fine, many-stranded girdles from Niue are common in museums. One in the Auckland Museum Collection (A.M. 24949) is made of the typical three-ply flat braid 1 mm. wide (Pl. 15, fig. 2), looped into a continuous skein a yard long, comprising almost 200 strands. The strands of the skein are secured by a twist in the centre, and the ends are seized with hair cord to form neat loops for fastening (Pl. 15, fig. 1).

**Society Islands.** Girdles of finely plaited hair were amongst the ornaments used in this group. Detailed information is not available, but Handy (1927 p. 108) quotes Wilson, who mentions girdles, "the braids of which were six or nine hairs in thickness," which would lead us to suppose that they were similar in form to those from Niue.

**Easter Island.** In describing the dress of the islanders, Metraux (1940, p. 216) mentions "the string of women's hair, the thickness of the

little finger," from which hung a form of grass kilt. It should be noted that this girdle is apparently worn as a single cord, and thus differs from those above, which consist of a skein of hair cords.

**Micronesia—Gilbert Is.** Handsome, many-stranded girdles, dark and glossy, are still worn by men in the Gilbert Islands as an ornamental fastening to secure the dancing mat at the hips.

Wilkes (1852, 2, p, 219) noted the use of these ornaments. "Long strings of beads or braided hair," he wrote, "are worn round the body, at times a hundred fathoms in length, which serve to fasten the mat."

In this group again the three-ply plait is most commonly used, but it is much coarser than in the Polynesian examples, being as much as 3 mm. wide. Three-ply cord used in these belts is also distinguished by a fringe formed of free ends of hair (Pl. 16, fig. 3). These girdles contain 9 to 12 strands of cord, knotted at the ends.

Another type of girdle (A.M. 25222, Maude Coll.), from Nonouti, in the Gilbert Is., is of four-ply cord in a round plait 2 mm. thick, in this type of cord without a fringe (Pl. 16, fig. 4). The cord is made up into a skein of about 20 strands, two yards long, bound at the ends with round cord.

## NECKLACES.

**Polynesia.** Necklaces in this area were made from hair cord, and differ from group to group only in minute details. The general form of this ornament is a thick, short skein of continuous cord, seized at the ends with hair or fibre and finished with eyelet holes or with cords for fastening. Hair necklets were worn either as suspension cords for shell or whale-ivory pendants, or without any additional ornament.

Their use is recorded from Cook Islands, Tongareva, Mangareva, Austral Is., Society Is., Marquesas Is., Hawaii and Easter Id.

**Micronesia—Gilbert Is.** Similar necklaces are still worn as dance ornaments in the Gilbert Islands. A specimen from Tabituea (A.M. 24110, Maude Coll.) in the Auckland Museum is a skein 32 cm. long consisting of 160 strands of fine three-ply braid 1 mm. wide, with plaited cords of hair for tying at the back of the neck (Pl. 15, fig. 4).

**Ellice Is.** A necklace of the same type from this group, in the American Museum of Natural History, is described by Linton (1923, p. 427) as being similar to those from the Marquesas.

**Polynesian Outliers—Sikiana.** A specimen of modern make from Sikiana is a smooth hair braid, 1.5 mm. wide, looped into three lengths and decorated with pearl buttons.

**Southern New Hebrides.** The Museum Godeffroy in Hamburg (Schmeltz and Krause, 1881) catalogues two specimens of human hair cordage from Aneityum. One, probably a necklace, is made up of cord 1 mm. wide, and the other is .5 mm. wide.

### Variations in Cordage Technique.

**Hawaii.** There are several variations from the usual three-ply braid used for these necklaces in most groups. In the handsome

Hawaiian neck ornament with its pendant ivory hook the heavy skein is made of 8-ply *square* braid 1 mm. wide. It is interesting to note here that in this specimen (A.M. 14537) approximately 350 yards of continuous cord have been used (Pl. 15, fig. 3).

**Mangareva.** Buck (1938) describes the *two*-ply *twisted* cord used here, three of these two-ply cords being twisted together into a rope from which a pearl shell is suspended.

## HEAD ORNAMENTS.

**Society Is.** Cords of finely braided human hair were bound round and round the head to form a turban. Handy (1927, p, 108) states that nothing of the method of preparing or of braiding the hair had been preserved in the memory of the Tahitians. He quotes Banks, who wrote that he had seen these braids "plaited scarcely thicker than a common pack-thread, in pieces above a mile in length, worked on end without a single knot," and Ellis, who saw such a head-dress containing 100 fathoms of braid.

**New Zealand.** Into this category falls a particularly interesting specimen in the Auckland Museum (A.M. 5329) (Pl. 15, fig. 2). This is a thick tuft of hair found at Waimamaku, almost certainly in a burial cave. The tuft, which must have been cut off close to the scalp, is bound together with a skein of extremely fine and delicate hair cord .7 mm. wide (Pl. 16, fig. 1). The flat three-ply braid consists of approximately 14 hairs. The plaits are bound together at one point with a flat binding of hair cord.

This specimen gains significance in the light of a reference by Elsdon Best (1924, p, 208), who writes, "a man would sometimes use a finely plaited cord formed from the hair of a slain enemy wherewith to confine his own top-knot of hair. It was termed a *kota*." This name seems to have been applied to hair cord in general. Williams (1921) defines it as "a rope of human hair used in certain rites."

Crozet (1891, p, 44, Ling Roth translation), who saw hair being braided into cord in the Bay of Islands in 1772, mentioned briefly "yarn of 5 or 6 strands of hair, which is very strong." He unfortunately gives us no details of its manufacture or its use; but that it might have occcurred widely in New Zealand, is suggested by Skinner's (1923, p, 93) record of the discovery of a piece of hair cord in a cave as far south as Otago.

**Niue.** A head ornament from Niue (A.M. 16858.4) is made from a cord of banana bark, surmounted by a band of yellow feathers, with a plume of white tropic bird feathers rising from the centre. The bases of the feathers are covered with a decorative binding of three-ply plaited hair cord interwoven with strips of white pandanus leaf to form a pattern.

## OTHER USES.

**Cook Islands.** Here Buck (1944, p, 117) quotes Gill as stating that the quantity of fine hair cord worn in necklaces and other ornaments indicated the rank of the wearer. In Mangaia plaited human hair was wrapped round and round the arms and ankles.

**Tahiti.** An ear ornament of finely plaited hair, with a button at one end and a sinnet seized loop at the other, is figured in the catalogue of the Oldman Collection (1943).

**Hawaii.** Slings used in warfare were made from coconut fibre and from pandanus leaf, and also from braided human hair.

## 2.—DECORATIVE CORDAGE.

Composite cord of sinnet and human hair occurs to some extent in both Polynesia and Micronesia.

**Polynesia—Cook Is.** Here fine sinnet braid was wrapped with human hair to form a smooth cord. This was used for decorative pendants and lashings on carved wooden gods. Hair-wrapped sinnet is also used in a cord figured by Buck (1944, p, 113), from Mangaia, where it was worn as a dress ornament by chiefs.

**Tahiti.** Edge Partington (1895, 2, p, 18) figures a length of twisted coconut fibre cord wrapped with human hair.

I have been unable to localize a long piece of cord in the Auckland Museum (A.M. 18092), although it is undoubtedly Polynesian. The four-ply hair plaiting tightly covers a core consisting of a single strand of strong fibre. The whole cord, which is round in section, is 1 mm. thick.

**Micronesia—Gilbert Is.** Handsome black and brown twine in which one ply of hair and one of coconut are twisted together is distinctive of many Gilbert Island handcrafts. It is used with decorative effect in the highly developed lashing patterns of this region, for binding sharks' teeth to the edges of wooden swords, and in the making of personal ornaments. Similar cord is recorded from the Ellice Islands.

## 3.—FISHING LINES.

**Polynesia.** Compared with decorative and ornamental hair cordage, that used in fishing lines would probably have been regarded as of little value, and specimens have thus not been preserved. It is possibly for this reason that there is little evidence of the use of hair cordage for fishing lines in ancient Polynesia.

The only available record of its use for this purpose is from ancient Tahiti. The Spaniard Joseph Amich wrote in his journal (trans. Corney, 1915, p. 81), "their fine lines are made of human hair deftly plaited, and the coarser ones of the fibre of the coconut palm."

**Micronesia.** In the Gilbert Islands fishing lines were frequently made of human hair. Such lines consist of a round 4-ply plait approximately 3 mm. thick. The fine cord used for lashing the point to the shank of the composite hook is also made from hair, and the snood is also whipped with it.

**Polynesian Outliers.** Fine hair lines of 3-ply plait in the Auckland Museum collections have come from Rennell Is. and from Sikiana. Both are approximately 3 mm. wide, and that from Rennell Is. is 92 feet long.

PLATE 15.

For cultural reasons, these images have been removed.
Please contact Auckland Museum for more information.

Fig. 1. Girdle of hair cord from Niue.
Fig. 2. Tuft of hair bound together with fine hair cord, Waimamaku, New Zealand.
Fig. 3. Neck ornament, Hawaii.
Fig. 4. Necklace of hair cord, Gilbert Islands.

## CONCLUSION.

This cordage depends upon the physical fact of long hair, and so has remained a stable element in Polynesian culture: the raw material has always been available, even in the changed environment of new islands. In addition to this purely physical fact, the distribution of hair cordage throughout the Gilbert Islands, Polynesia and the Polynesian outliers, would suggest that its use was a feature of the early culture shared by the Polynesians before their dispersal from a common home. Hair cordage made up into ornaments of related type occurred in the Society Islands, Hawaii, New Zealand and other groups. Its use must have been established before the emigration of settlers from Central Polynesia to the surrounding islands.

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EXAMPLES OF HAIR CORDAGE.

Fig. 1. Three-ply hair cord, Waimamaku, New Zealand.
Fig. 2. Three-ply hair cord from girdle, Niue.
Fig. 3. Fringed three-ply hair cord from girdle, Gilbert Islands.
Fig. 4. Round four-ply cord from girdle, Gilbert Islands.

# Arachnoidism As Applied To New Zealand Spiders

## A PRELIMINARY NOTE.

By G. CHAMBERLAIN.

Arachnoidism is a medical term meaning "the condition produced by the bite of poisonous spiders." Early records of supposed spider bites were centred around a spider of the family Lycosidæ found in Europe. The stories told of tarantism and the ceremonial dance used as a cure are so well known that no purpose can be served by repeating them here. The most remarkable feature of arachnoidism is its limitation to the spiders of one widely distributed sub-family, the Latrodectinæ. Two genera of this sub-family, *Dipœna* Thorell, 1870, and *Latrodectus* Walckenær, 1805, are represented in New Zealand fauna. The bites of spiders not classified in this sub-family are generally thought to produce no more than temporary inconvenience. Such opinion is not based on recorded facts, but is more an indication of our ignorance of the subject of Arachnoidism as a whole. Of later years much has been recorded on this subject. The purpose of the present note is to place on record brief comments on cases of spider-bite that have come under the notice of the author.

In New Zealand a large number of cases have been reported in the daily newspapers. In the majority of these there is considerable doubt as to the class of animal that delivered the bite. In very few instances is the spider actually seen, and in fewer still is it captured and identified. In each of the records below the specimen was taken and preserved for study. In three of the cases the spider was forwarded by the victim to the Auckland Institute and Museum, and now rests in the Museum collection.

### **Latrodectus** spp.

Arachnoidism in which the well-known "Katipo" was the accused, is not considered at this time. It is hoped to deal fully with the effects of a bite from this spider at some later date.

### **Dipœna blattea (Urquhart, 1885).**

Two cases are known to the author in which this spider has delivered a bite to a human being. In the first case the spider became entrapped in the shirt front of the victim. The bite was located on the lower portion of the chest. The symptoms which followed the bite are best described in the words of the victim:—

"About ten minutes afterwards a violent itching occurred around the bite and spread all over my body. This became so distressing that I got into a bath of water. By this time my body looked as though I had been sun-bathing, and been rather badly sunburnt, while a sort of heat rash broke out all over me and my head felt as though I was in the throes of a cold. This condition lasted for an hour or so, and then gradually decreased. . . ."

In the second case the symptoms following the bite were described by the attending medical practitioner as jaundice accompanied by local motor paralysis. The bite was located on the upper third of the left thigh.

**Hexathele hochstetteri** Ausserer, 1871.

The bite was located on the back of the right hand. Two punctures were visible, about three-sixteenths of an inch apart. A swelling of the hand commenced in half-an-hour and reached a maximum in one to two hours. Slight irritation occurred for the first two hours. The site of the punctures was tender to the touch for some six to eight hours, after which the condition rapidly returned to normal.

**Porrhothele antipodiana** (Walckenaer, 1837).

A previous record was published by Myers (*N.Z. J. Sci. Tech.*, 9, 129, 1927). In a further case of a bite by this species there was slight bleeding at the two punctures. These punctures were situated on the thigh directly over the femoral artery, and were about one-quarter of an inch apart. Rapid swelling followed the bite, which in about an hour was surrounded by an edematous area some two inches in diameter. Surface irritation caused some discomfort for the first two hours. The patient developed a fever (temperature 102° F., pulse 92) twelve hours later. Medical attention was sought, and an intravenous injection of an opiate was given. No further notes were made at the time, but it is known that a septic sore developed at the site of the punctures. The patient had fully recovered at the end of three weeks.

**Desis marina** (Hector, 1877).

An instance is known of a dog receiving a bite from this species. The spider pierced the soft skin between the toes of a foreleg. The foot swelled and appeared to be paralysed for some twelve hours. It is possible that this species may be able to bite humans and cause some inconvenience.

**Ixeuticus subfasciatus** (Simon, 1899).

It is difficult for this species to penetrate the human skin. When it does succeed in biting there is very little pain, and there are no after effects.

**Cambridgea foliata** (L. Koch, 1873).

The two punctures were on the left thigh about midway between the hip and knee joints. Only slight pain was felt at the bite, and no symptoms appeared for about six hours. At this time an intense itching

developed, and a swelling commenced at the site of the punctures. At the end of the third day the swelling covered an area roughly seven inches in diameter, and was causing considerable pain. Vesication was observed at the site of the punctures, consisting of a lymph-filled blister about half an inch in diameter, and surrounded by a narrow erythematous area. The application of tincture of iodine appeared to increase the irritation. On the fourth day the swelling began to subside. A scar tissue formed under the blister, and the upper layer of skin sloughed. At the end of a week the condition of the patient had returnd to normal.

This same species has been observed to bite and kill a specimen of *Zosterops lateralis* (Latham) that had become entangled in its web. It is interesting to note that although the spider attacked and killed the bird it immediately cut the victim from its web and let it fall to the ground.

# Phylogeny of the Molluscan Genus Verconella, With Descriptions of New Recent and Tertiary Species

By A. W. B. POWELL, Assistant Director.

The present paper is supplementary to my Variation of the Molluscan Genus Verconella with Descriptions of New Recent Species (*Trans. N.Z. Inst.* 57, pp. 549-558). Four new Recent species, a new Recent subspecies and two Tertiary species are here described. The total of New Zealand Recent forms is now fourteen, and the fossils twenty three. In the past, alternative use of the genera *Verconella* and *Austrosipho* for New Zealand shells has caused some confusion, and now four generic names must be considered in reviewing the Austro-Neozelanic series. They are:—

*Austrosipho* Cossmann, 1906.
Essais Pal. Comp. 7, p. 229.
Type (o.d.): *Siphonalia roblini* Tate.
Table Cape, Tasmania (Janjukian).
Lower Miocene.

*Berylsma* Iredale, 1924.
P.L.S.N.S.W. 49, p. 267.
Type (o.d.): *Fusus waitei* Hedley, 1903. 79-80 fath. off Botany Bay, New South Wales.

*Largisipho* Iredale, 1929.
Rec. Aust. Mus. 17 (4), p. 182.
Type (o.d.): *Largisipho oligostira spectanda* Iredale, 1929.
50-60 fathoms off Montagu Is., N.S.W., Australia.

*Verconella* Iredale, 1914.
Proc. Malac. Soc. 11, p. 175.
Type (o.d.): *Fusus dilatatus* Quoy & Gaimard.
25 fathoms, Bay of Islands, New Zealand.

Finlay, 1927 (*Trans. N.Z. Inst.* 57, pp. 503-504), has shown that the protoconch is distinctively consistent for the two series. That is, the Australian *Austrosipho* with "a globular paucispiral protoconch, quite asymmetrically wound, the nucleus being bulbous and lateral," and the New Zealand *Verconella*, which has "a tall pupoid, polygyrate protoconch, with the nucleus small and central, the whole thing being symmetrically wound." Finlay, 1930 (*Trans. N.Z. Inst.* 61, p. 71), states also that "If genera are to express lineages, I do not see how *Largisipho* Iredale can be maintained as distinct from *Austrosipho*; *L. spectanda*,

the genotype, is evidently a terminal Recent member of the Tertiary *roblini* line." Cotton and Godfrey, 1932 (*The South Australian Naturalist,* 13 (2), p. 75), synonymise *Largisipho* with *Berylsma.*

The genus *Berylsma* was proposed for colourless, elongate-fusiform shells from deep water off the coast of New South Wales. They are regularly axially costate and have a very even alternation of primary cords with mostly a single thread in each interspace. I have not seen the protoconch of the genotype.

One of the new species described herein, *V. fairfieldæ*, has a regular alternation of spiral sculpture and broad axial folds comparable with the *Berylsma* style of sculpture, but since this sculptural plan can be matched in a New Zealand Tertiary series, there is no reason to claim direct relationship between the New Zealand Recent *fairfieldæ* and the Australian *B. waitei.*

Since *Verconella* is now known to extend back to the Wangaloan (Danian) in New Zealand (Finlay & Marwick, 1937, N.Z. Geol. Surv. Pal. Bull. 15, p. 76) there is justification for the employment of *Verconella* generically and exclusively for the New Zealand series, leaving the evaluation of the *Austrosipho-Berylsma-Largisipho* complex as an Australian problem.

Both *Verconella* and *Austrosipho* have, throughout the Tertiary, developed independently on opposite sides of the Tasman and in each country there are recognisable groups of species. A well-marked New Zealand Miocene group, the *finlayi-marwicki* series, is characterised by the presence of strong spiral ridges on the base, one often causing angulation.

In my 1927 paper I defined two groups of the New Zealand Recent Verconellas as follows:—

"A. **Dilatata** (typical) group.

Confined to deep water. Comparatively thin shell. Operculum horny, inside with a white callus along outer margin of muscle-scar. Protoconch of three and a half to four convex whorls, always brown.

"B. **Adusta** group.

Littoral to comparatively deep water. Heavy shell. Operculum horny, inside always minus the white callus. Protoconch of two and a half to three whorls, only slightly convex and always white."

The New Zealand Recent and fossil *Verconellas* resolve into the following groups:—

**1. proavita Finl. & Marw. 1937.**

A small species with moderately strong spirals and axials. Protoconch unknown. It is the earliest known *Verconella.* Boulder Hill; Wangaloan (Danian). A new species too imperfect for description from Waihao Downs; Bortonian (Middle Eocene) is in the Finlay collection; Auckland Museum. The Waihao species is nearer to *proavita* than to any of the later groups.

## PROTOCONCH TYPE B.

### 2. The finlayi-marwicki series.

These shells are large and solid with strong rounded peripheral nodules. On the base there are several spiral ridges much stronger than the rest and one of these often forms a basal angulation or keel. The series consists, in ascending order, of *finlayi* Laws. 1930, *marwicki* Finlay, 1930, *latispinifer* Marwick, 1932, *crawfordi* (Hutton, 1873), *masoni* and *takapauensis* Fleming, 1943, and *huttoni* King, 1934. The range is Otaian (Middle Oligocene)* to Tongaporutuan (Upper Miocene). The series terminates in very solid, strongly nodulous species representing apparently a gerontic offshoot from the main trend.

### 3. The clifdenensis series.

This group differs from the last in being of lighter build and in having finer surface sculpture. On the base, however, there is the same tendency to develop occasional spirals heavier than the rest. The peripheral nodules are vertically compressed. The series was probably of deep-water occurrence and the *finlayi-marwicki* series shallow-water. The finding of Upper Miocene and Lower Pliocene representatives of the "deep-water" fine-sculptured group would probably indicate that the *clifdenensis* series are ancestral to the *dilatata* series. I consider the *clifdenensis* series as an offshoot of the *finlayi-marwicki* line in its early stages of development.

The series consists of *bartrumi* Laws, 1941, *parans*, *affixa* and *clifdenensis* Finlay, 1930, and possibly *exoptatus* Bartrum & Powell, 1929. The latter species by its vertically compressed nodules, yet heavy basal keels, is probably a gerontic offshoot of the *clifdenensis* series rather than a member of the *finlayi-marwicki* series. The known range of the *clifdenensis* series is Altonian and Clifdenian (Lower Miocene).

### 4. The adusta series.

This series undoubtedly originated from the *finlayi-marwicki* series before the crass trend took place. The species in order of appearance are *koruahinensis* Bartrum & Powell, 1928, *haweraensis* Powell, 1931, *accipitris*, *allani* and *falsa* Finlay, 1930, *edita* Powell, 1934, and the Recent forms *adusta* (Philippi), *adusta mandarinoides* Powell, 1927, *adusta worthyae* n. subsp., and *adpressa* n. sp. The range is Opoitian (Lower Pliocene) to Recent.

### 5. The mandarina series.

These shells have strong sculpture of sparse primary cords with a varying number of threads between them. The whorls are strongly convex and without either a peripheral angulation or axial sculpture. There is an undoubted member of this series in the Petane beds, Nukumaruan (Middle Pliocene); a new species more inflated than typical *mandarina*. Finlay's (1926) record of *mandarina* from the Castlecliffian refers to half-grown examples of *falsa*.

* Finlay, H. J. and Marwick, J., 1947. New Divisions of the New Zealand Upper Cretaceous and Tertiary. N.Z. Journ. Sci. & Tech. 28 (4), Sec. B., pp. 228-236.

### 6. The interjuncta-fairfieldæ series.

This is probably another offshoot from the *finlayi-marwicki* series or alternatively from earlier stock which gave rise to both. They are characterised by regular sculpture of broad low spiral cords with a single thread in each interspace. The species are the Awamoan (Upper Oligocene) *imperfecta, interjuncta* Finlay, 1930, *asper* Marwick, 1928, and the Recent *fairfieldæ* n. sp.

## PROTOCONCH TYPE A.

These are all large, deep-water shells of thin build and fine spiral sculpture. There are three groups, (1) the *ormesi* series characterised by evenly convex whorls without nodules; (2) the *dilatata* series, broad forms with strong vertically compressed peripheral tubercles; and (3) the *elongata* series, forms similar to the last, but narrow and elongate.

### 7. The ormesi series.

The earliest record is *Verconella ormesi* Powell (Marwick, 1931, N.Z. Geol. Surv. Pal. Bull. 13, p. 40), from Tutamoe Beds (Middle Miocene). The series includes a new species from Nukumaru (Middle Pliocene), juveniles of a species allied to if not identical with *ormesi*, from Castlecliff (Upper Pliocene), and two Recent species, typical *ormesi* Powell, 1927, and *chathamensis* Powell, 1938.

### 8. The dilatata series.

The only known fossil occurrence of this series is *dilatata* typical from uppermost Castlecliffian beds at Te Piki, near Cape Runaway. Powell, 1934 (Rec. Auck. Inst. Mus. 1, p. 264). The species are *dilatata* (Quoy & Gaimard, 1833), *dilatata cuvieriana* and *d. rotunda* Powell, 1927, and *dispar* n. sp.

### 9. The elongata series.

The earliest known occurrence of this series is *hiatula* n. sp. from the Nukumara blue clays and the lower Kai Iwi blue clays, Nukumaruan to Lower Castlecliffian (Middle and lower beds of the Upper Pliocene). The Recent members are *elongata* Powell, 1927, and *jeakingsi* n. sp.

## COMPARATIVE ANALYSIS OF SPIRAL SCULPTURE.

The spiral sculpture in the Verconellids is difficult to describe, for there is not only a fair amount of individual variation in the strength, number and arrangement of the cords and threads, but also the sculpture varies from whorl to whorl in any one shell. The tendency is for the primaries to become sparse with an increasing number of interstitial threads as the whorls increase.

The following table is a comparative evaluation of the spiral sculptural detail in six of the species discussed herein. The formulæ show the number of primary and secondary spirals per centimeter for the lower spire whorls ("S-W."); and the same for the upper part of the body-whorl ("B-W.").

## GROUP A (Typical protoconch).

*dilatata*

Spiral sculpture almost uniformly fine; primary spirals only slightly stronger than secondaries.

S-W. 13-14 primaries + 1-3 intermediates = 18-25 spirals.

B-W. 4-9 primaries + 3-4 intermediates = 13-20 spirals.

*dispar* n. sp.

Spiral sculpture of broad low cords and a varying number of much narrower intermediates.

S-W. 7-8 primaries + 2-3 intermediates = 23-24 spirals.

B-W. 5-6 primaries + 2-4 intermediates = 17-22 spirals.

## GROUP B protoconch.

*adusta*

Spiral sculpture irregular, consisting of rather distant moderately strong cords with a median subsidiary cord in most interspaces and fine threads in varying numbers on either side of it.

S-W. 6-8 primaries + 1-8 intermediates = 23-31 spirals.

B-W. 3-4 primaries + 2-8 intermediates = 20-27 spirals.

*mandarina*

Spiral sculpture consisting of a few heavy primary cords and much weaker intermediate threads.

S-W. 4-6 primaries + 1-3 intermediates = 10-12 spirals.

B-W. 3-4 primaries + 1-4 intermediates = 8-10 spirals.

*adpressa* n. sp.

Spiral sculpture rather weak, consisting of irregular cords and a varying number of intermediate threads.

S-W. 7-8 primaries + 1-3 intermediates = 16-19 spirals.

B-W. 4-6 primaries + 1-3 intermediates = 18-19 spirals.

*fairfieldæ* n. sp.

Spiral sculpture of broadly rounded cords with a single thread in each interspace.

S-W. 6-7 primaries + 1 intermediate = 11-13 spirals.

B-W. 3-4 primaries + 1 intermediate = 7-11 spirals

**Verconella dispar** n. sp. Pl. 18, fig. 3.

A member of the typical (*dilatata*) series, characterized by a lower peripheral angulation and distinctive sculpture.

Spire angle 58 degrees. Aperture + canal 1.468 times height of spire. Adult whorls 7, plus a typical protoconch of four whorls. Peripheral angle just below the lower third of the whorl height. The angle is defined by a broad smooth spiral cord and is without nodules except for the first 3-4 post-nuclear whorls, which have weak axial folds, about 10 per whorl. The angulation almost disappears over the last half whorl

and is strongest on the antepenultimate and penultimate. Surface sculpture of broad low smooth slightly convex primary cords and a varying number of much narrower intermediates. On the later spire-whorls the primaries number 7-8 per centimeter with from 2-3 threads in each interspace, making a total of from 23-24 spirals per centimeter. On the base the primaries are 5-6 per centimeter, the intermediates 2-4, and the total, 17 to 22 spirals per centimeter. The aperture has a heavier callus than usual for the group, resulting in a raised callus plate over the parietal wall and a distinct varix within the outer lip. This varix is distinctly spirally lirate. Colour buff to pale-brown; aperture and apertural callus dull white. The free parietal callus and outer-lip varix, coupled with stronger sculpture than usual for the *dilatata* series, place *dispar* nearest to *rotunda* Powell, 1927. In *rotunda* the angulation is median, nodulous throughout, and the spiral sculpture is crossed by dense axial growth threads.

Height, 155 mm.; diameter, 68 mm.

*Locality:* Off Cape Campbell, Marlborough, 30-40 fathoms. Trawler "Futurist," 1925.

*Holotype:* In the writer's collection, Auckland Museum. The only known specimen.

**Verconella hiatula** n. sp. Pl. 17, fig. 3.

The first known member of the *elongata* series. It differs from all other species in having the middle whorls devoid of axials. Spire angle 45 degrees. Aperture + canal 1.308 times height of spire. Adult whorls 8; protoconch missing. Periphery situated from below the middle to the lower third of whorl height, bluntly angled on the whorls bearing axials but narrowly rounded on those devoid of axials. First four post-nuclear whorls with fold-like axials, next three whorls including the penultimate without axials, body-whorl with eight blunt slightly vertically compressed prominent nodules. The shoulder is broadly but distinctly concave, and descends at an angle of 145 degrees to the axis of the shell. Surface sculpture fine of approximately evenly developed threads, 25-28 per centimeter. Three to five slightly stronger spirals traverse the peripheral nodules. Aperture finely lirate within the slightly thickened outer lip.

Height, 125 mm.; diameter, 56 mm.

*Locality:* Lower Kai Iwi blue clays, sea-cliffs between Kai Iwi and Okehu. Lower Castlecliffian (Upper Pliocene). Collected A.W.B.P., Jan., 1927. Nukumaru blue clay, Nukumaruan (Middle Pliocene).

*Holotype:* In writer's collection, Auckland Museum.

The Nukumaruan record is based upon Finlay's paratype of *V. allani* Finlay, 1930 (Trans. N.Z. Inst. 61, p. 71). The holotype of *allani* is, as stated by Finlay, a relative of the Castlecliffian *falsa* and is probably directly ancestral to it. These shells belong to the *adusta* series, for they are more coarsely sculptured and have a greater spire angle than the *elongata* series.


Fig. 1. *Verconella jeakingsi* n. sp. Holotype, 154 x 65 mm.
Fig. 2. *Verconella adusta worthyæ* n. subsp. Holotype, 139 x 67 mm.
Fig. 3. *Verconella hiatula* n. sp. Holotype, 125 x 56 mm.
Fig. 4. *Verconella* aff. *mandarina*. 115 x 60 mm.
Fig. 5. *Verconella adpressa* n. sp. Holotype, 120 x 62 mm.

**Verconella jeakingsi** n. sp. Pl. 17, fig. 1.

A second Recent member of the *elongata* series characterized by its narrow form, attenuated spire, bluntly rounded peripheral nodules and exceedingly fine, crowded and evenly developed spiral-thread sculpture. Spire angle 30-35 degrees. Aperture + canal 1.185 times height of spire (i.e., apex to top of aperture). Adult whorls 8, plus a typical protoconch of $3\frac{1}{2}$ whorls (damaged in holotype). Peripheral angle at the middle, bearing prominent bluntly-rounded nodules, 10 on the penultimate. Shoulder descending at 130° to the axis of the shell. Surface sculpture finely and evenly developed, 20-25 threads per centimeter on middle whorls. Weak primaries occur below the periphery and become distant over the lower part of the base. Colour buff diffused with pale orange-brown. Apertural callus pinkish-white, outer-lip margined within by diffused orange-brown.

The species is nearest allied to *elongata* from 19 fathoms off Whale Island, Bay of Plenty. In *elongata* the spire-angle is 45-50 degrees, the aperture + canal 1.519 times height of spire, and the shoulder descends at about 150° to the axis of the shell. Briefly, *jeakingsi* in proportions differs from *elongata* in having the spire narrower, but the body-whorl more inflated.

Height, 154 mm.; diameter, 65 mm.

*Locality:* Trawled in Cook Strait, probably Tasman Bay, Nelson, Mr. Jeakings, per Mrs. I. Worthy.

*Holotype:* In Auckland Museum, presented by Mrs. I. Worthy. Paratypes in Mrs. Worthy's collection.

**Verconella adusta worthyæ** n. subsp. Pl. 17, fig. 2.

A south Cookian member of the *adusta* series which stands nearest to the Bay of Plenty *adusta mandarinoides*. In typical *adusta* the whorls are strongly keeled and nodulous throughout; in *adusta mandarinoides*, axial folds, nodules, and a weak peripheral keel are present on the early whorls but the latter half of the penultimate and the body-whorl are strongly and evenly convex, weakly subangled at most, and always devoid of nodules. In *adusta worthyæ* the first two or three post-nuclear whorls are rounded and weakly axially costate; the following two whorls are rounded and entirely without nodules, but the penultimate and the body-whorl have a peripheral keel which bears distant vertically compressed nodules commencing early on the penultimate and terminating half a whorl back from the aperture. The nodules number nine per whorl. Spire angle 55°, aperture + canal 1.366 times height of spire. Adult whorls 6, plus a typical "*adusta-type*" protoconch of $2\frac{1}{2}$ whorls. Spiral sculpture irregular, consisting of rather distant moderately strong cords with a median subsidiary cord and a varying number of fine threads in each interspace. Primary cords 4 to 8 per centimeter; interstices mostly with a subsidiary cord and 2 to 4 threads; total number of spirals per centimeter varying between 15 and 21. Colour buff, stained with pale reddish-brown; apertural callus white.

Height, 139 mm.; diameter, 67 mm.

*Locality:* Trawled in Cook Strait, probably Tasman Bay, Nelson. Mr. Jeakings, per Mrs. I. Worthy.

*Holotype:* In Auckland Museum, presented by Mrs. I. Worthy. Paratypes in Mrs. Worthy's collection.

**Verconella adpressa** n. sp. Pl. 17, fig. 5.

A member of the *adusta* series, nearest to *adusta mandarinoides*. The species is characterised by a complete absence of axials and a deeply concave shoulder, resulting in an adpressed suture and a constricted anterior canal. Shell broadly fusiform with inflated whorls, evenly convex except for the shoulder concavity. Spire angle 70 degrees. Aperture + canal 1.460 times height of spire. Adult whorls 5 (apex missing). Surface sculpture rather weak, consisting of irregular cords and a varying number of intermediate threads. The spire-whorls have 7-8 primary cords per centimeter and the body-whorl 4-6 per centimeter. The intermediates vary between 1 and 3. Parietal callus heavy, with a raised edge and a spiral ridge-callus, scarcely a tubercle, which combined with the insinuation of the outer lip over the shoulder causes a considerable constriction of the anterior canal. Outer lip thickened within and weakly lirate. The apparent false-umbilicus associated with the posterior canal is adventitious, having been caused by vertical borings up from the base of the pillar. The anterior canal has been forced 7 mm. from its axis to avoid the borings, which consist of four 3 mm. diameter holes. Colour buff with the spiral sculpture lined in light reddish-brown. Interior of aperture and apertural callus dull white.

Height, 120 mm. (estimated); diameter, 62 mm.

*Locality:* Off Maunganui Bluff, West coast of North Auckland Peninsula, 50 fathoms.

*Holotype:* In the writer's collection, one of three specimens obtained from a local trawler by the late Dr. E. N. Drier in 1927. The other two specimens should be in the Drier collection, Vancouver Museum.

**Verconella aff. mandarina** n. sp.? Pl. 17, fig. 4.

This is the only undoubted fossil member of the *mandarina* series known to the writer. It is probably a new species, for it is much shorter and broader than Recent shells. Unfortunately almost all the surface sculpture has been defaced, so description is withheld pending the finding of better material.

Height, 115 mm. (estimated); diameter, 60 mm.

*Locality:* Petane beds, Hawke's Bay. Nukumaruan (Middle Pliocene). N.Z. Geological Survey, Wellington.

**Verconella imperfecta** n. sp. Pl. 18, figs. 6 and 7.

Shell broadly fusiform with a deeply concave shoulder. Periphery narrowly rounded and situated just below the middle of whorl height. Sculptured with broad fold-like axials 11-12 per whorl, extending from suture to suture but very weak over the shoulder. Surface sculpture of broadly rounded smooth spiral cords mostly with a single thread in each interspace. The cords number 10-11 on the spire whorls and there are from 8-10 per centimeter. On the base they are about 6 per centimeter. Spire angle 70 degrees.

Height, 85 mm. (estimated); diameter, 44 mm. (estimated).

*Localities:* Awamoa (holotype), near Oamaru. Awamoan (Upper Oligocene); Pareora, Otaian (Middle Oligocene). N.Z. Geological Survey Collection

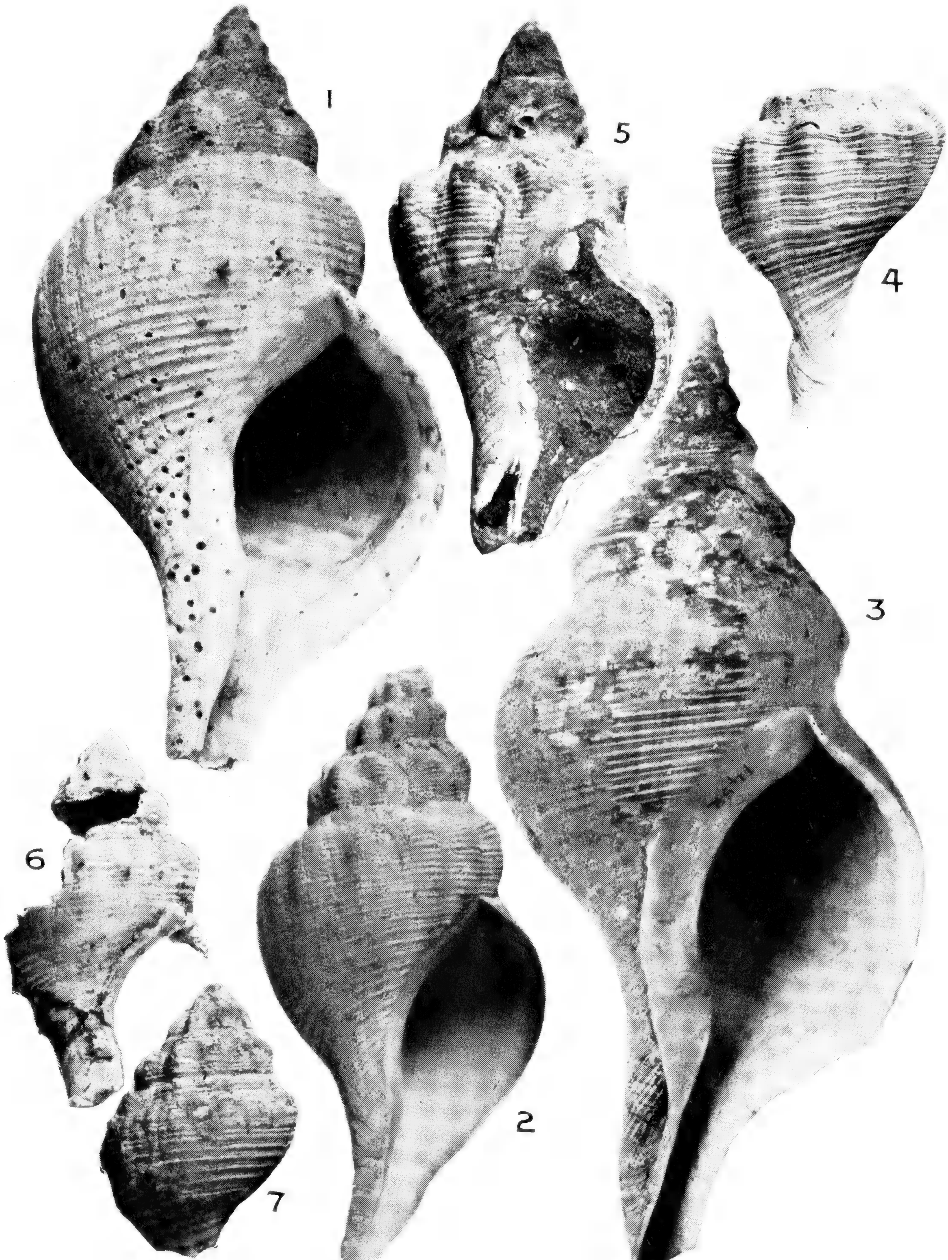


Fig. 1. *Verconella fairfieldæ* n. sp. Holotype, 120 x 62 mm.
Fig. 2. *Verconella fairfieldæ* n. sp. Paratype.
Fig. 3. *Verconella dispar* n. sp. Holotype, 155 x 68 mm.
Fig. 4. *Verconella interjuncta* Finlay, 1930. Holotype.
Fig. 5. *Verconella interjuncta* Finlay, 1930. Topotype, 84 x 46 mm.
Fig. 6. *Verconella imperfecta* n. sp. Holotype, 68 x 44 mm.
Fig. 7. *Verconella imperfecta* n. sp. Pareora.

*Holotype:* In N.Z. Geological Survey, Wellington. The material upon which *imperfecta* is based is very imperfect, but since it is apparently the earliest member of a line which has survived to Recent times the naming of the species seems to be warranted.

For comparison I provide figures of the holotype (Pl. 18, fig. 4) and a topotype (Pl. 18, fig. 5) of *V. interjuncta* Finlay, 1930 (Trans. N.Z. Inst. 61, p. 68), since the species has not been figured previously.

**Verconella fairfieldæ** n. sp. Pl. 18, figs. 1 and 2.

Broadly fusiform with strongly convex whorls; not keeled or angled at the periphery, but there is a marked subsutural concavity occupying the upper third of the whorl height. Spire angle 70 degrees. Aperture + canal 1.442 times height of spire. Sculptured with broadly rounded prominent axial folds, extending from suture to suture, but weak over the subsutural concavity. Axials 10-11 per whorl, subobsolete to obsolete over the body-whorl. Surface regularly sculptured with broadly-rounded slightly raised spiral cords, with a single thread in each interspace, except for a narrow zone immediately below the suture where there are no interstitials, and the lower part of the base where the interstitials increase to three. There are 18 spiral cords on the penultimate, the uppermost five being closely spaced and without interstitial threads. The protoconch is missing in the three known examples. Colour pale buff; apertural callus and interior of aperture dull white.

Height, 120 mm. (estimated); diameter, 62 mm. (holotype).

Height, 158 mm. (estimated); diameter, 70 mm. (paratype).

*Locality:* Trawled off eastern coast of Otago.

*Holotype:* Presented by Mrs. M. E. Fairfield, in Auckland Museum. Paratype in Mrs. Fairfield's collection.

This species does not belong to the *adusta* group, but is evidently a surviving member of a Tertiary line represented by the Otaian-Awamoan (Middle and Upper Oligocene) *imperfecta* n. sp., *Verconella interjuncta* Finlay, 1930, from Clifden (band 8A) Waiauan (Middle Miocene) and *V. asper* Marwick, 1928, from Flower Pot Harbour, Chatham Islands, Opoitian? (Lower Pliocene). They differ from all other members of the genus in the regularity of the sculpture, which consists of prominent broadly rounded primary spiral cords with a single thread in each interspace and broad fold-like axials extending from the lower suture to above the periphery, but weak on the concave shoulder.

The only related group with similar regular sculpture is the benthic New South Wales *Berylsma*, but these shells are more elongate-fusiform with a long canal and according to Cotton & Godfrey, 1932 (South Aust. Naturalist 13, (2), p. 75), have a few-whorled globular smooth protoconch. The protoconch in a juvenile paratype of *interjuncta* is of three smooth whorls and in shape is nearest to that of *adusta*.

# On Tolema peregrina *n. sp.* And The East Australian Warm Water Current

By A. W. B. POWELL, Assistant Director.

The species described below adds a genus to the New Zealand Recent fauna and at the same time provides further evidence of the effectiveness of the Notonectian or East Australian warm water current in establishing species of East Australian origin in New Zealand seas.

The list of molluscs which can be assumed to have reached New Zealand in this manner is now a lengthy one, and to it can be added a number of East Australian fish records (Powell, 1938, pp. 151-156), the starfish *Asterodiscus truncatus* Coleman (Powell, 1937, p. 78), a deep-water pipe-sponge, *Chondropsis syringianus*, and a new species of frog-crab, *Lyreidus* (the latter two, previously unpublished records).

The chief references to the effects of this warm water current upon the New Zealand fauna are contained in the following references: Finlay, 1925, 1926 and 1931; Fleming, 1944; and Powell, 1927, 1937 and 1940.

The species assumed to have been derived through the agency of the Notonectian current fall into three categories: (1) descendants of an early (Upper Pliocene) influx which has become firmly established in New Zealand but the modern representatives have developed new characteristics warranting specific differentiation; (2) species that are firmly established in New Zealand but are specifically inseparable from East Australian stock; (3) species which may be considered as having reached here and developed as odd individuals, but in insufficient numbers to cause the species to become permanently established.

Finlay (1926) and later Fleming (1944) have pointed out that the Castlecliffian Upper Pliocene marks the first advent of this new East Australian element in our fauna and presumably dates the first effective operation of this current in respect to New Zealand.

The faunal evidence indicates that either the current was more effective in its presumed initial Upper Pliocene stages or that the larvæ of certain species, particularly of the *Cymatiidæ*, come across regularly and in considerable numbers, thus nullifying the potential isolation factor and keeping the species true to type on each side of the Tasman.

## TOLEMA Iredale, 1929.

Rec. Aust. Mus. 17 (4), p. 186.

Type (o.d.): *Purpura sertata* Hedley.

In addition to the New South Wales deep water genotype there are several closely allied Japanese species, notably *lischkeana* (Dunker) and *japonica* (Dunker).

Iredale's genus was provided for the normally coiled members of *Latiaxis* sensu lato. Typical *Latiaxis* is thus restricted to the bizarre, flat to concave-spired, partially uncoiled shells grouped around the Japanese genotype *L. mawæ* (Griffith & Pidgeon).

These shells belong to the *Magilidæ* (= *Coralliophilidæ*) and are closely related to the *Muricidæ*.

**Tolema peregrina** n. sp. Pl. 19, fig. 3.

Shell large for the genus, biconical with sharply angulate whorls, long rather straight canal and dense sculpture of erect to recurved hollow spines. Whorls six, exclusive of the protoconch, which is eroded. Spire about two-thirds height of aperture plus canal. Whorls sharply angled from above the middle to about two-thirds whorl height on later whorls. The peripheral angle is coronated by prominent, closely-spaced, almost overlapping, vertically compressed, hollow, recurved spines, which have also an upward tilt. They number about 14 on the antepenultimate, 18 on the penultimate and 29 on the body-whorl. On the shoulder there are from three to four spiral series of hollow upcurved spines. Below the shoulder on the spire-whorls there are three to four similar rows of spines with a fifth emergent towards the termination of the last whorl. On the body-whorl below the peripheral carina there are fifteen spiral rows of almost evenly developed hollow upcurved spines, the lowest strongly developed on a sweepingly arcuate, narrowly ridged fasciole which defines a broadly open deep false umbilicus. The anterior canal is long, narrowly open, and is only slightly recurved. Colour of exterior dull creamy buff. Interior of aperture white, glazed, with a lilac tinge inside the canal and on the lower extremity of the pillar.

Height, 51.0 mm.; diameter, 33.5 mm.

*Locality:* Trawled on *Atrina* beds near the entrance to Hauraki Gulf, probably in about 20-25 fathoms.

*Holotype:* Presented by Miss N. Houghton.

The New Zealand *Tolema* is very close to the New South Wales *sertata*, but as far as can be judged from the sole available New Zealand example, a different regional species has developed. Actual specimens of *sertata* compared with Iredale's figures (1929, Pl. 41, figs. 3 and 8) show the New South Wales species to be remarkably constant.

The New Zealand shell differs from *sertata* in having a proportionately shorter spire, more evenly developed spiral rows of spines, not alternately strong and weak, up to four instead of three spirals on the shoulder, and an almost straight to slightly recurved anterior canal.

Hedley (1903, p. 383, fig. 96) gave an excellent drawing of the protoconch of *sertata*, which shows a perfect "sinusigera," indicating a larva of the lengthy free-swimming type.

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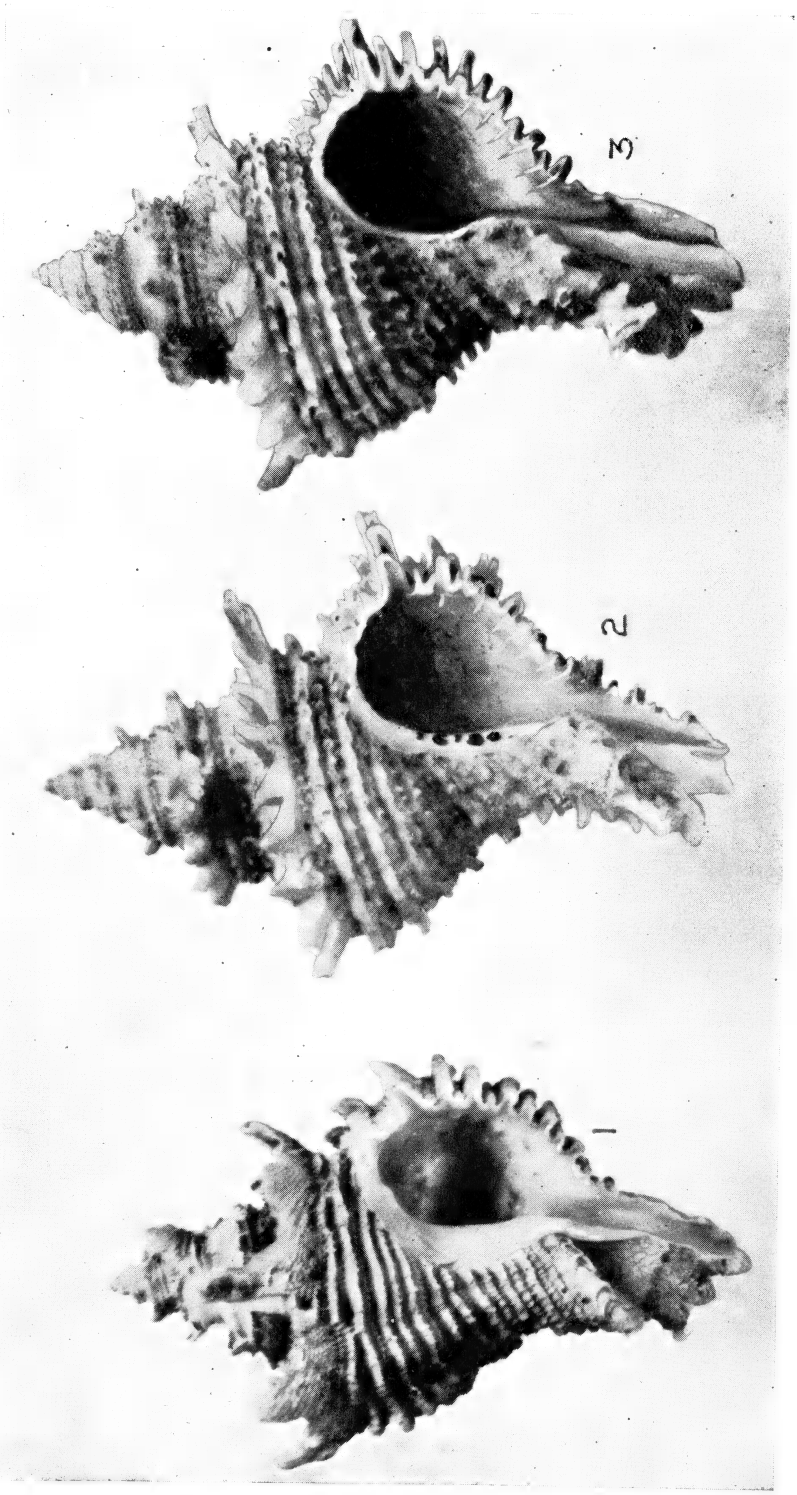


Fig. 1. *Tolema japonica* (Dunker), Japan, 47 x 29 mm.
Fig. 2. *Tolema sertata* (Hedley, 1903). New South Wales, 49.5 x 33 mm.
Fig. 3. *Tolema peregrina* n. sp. Hauraki Gulf, New Zealand, 51.0 x 33.5 mm. (Holotype).

# Distribution of Placostylus Land Snails in Northernmost New Zealand

By A. W. B. POWELL, Assistant Director.

This paper deals exclusively with living and extinct colonies of the large land snail *Placostylus ambagiosus* Suter.

The writer now recognises ten subspecies, including the typical one, and of this number six are here described as new. Of the ten subspecies five are Recent and still living, one has become extinct within Recent times, and the remainder are from consolidated dunes probably of Pleistocene age.

The distributional areas and the mode of occurrence of the fossil subspecies provide the basis of interesting speculation regarding Pleistocene and Post Pleistocene climatic and topographic changes.

The area concerned is the extreme northern block of the North Auckland Peninsula. It extends from Cape Maria van Diemen in the north-west to North Cape to the east, and is bounded to the south by both the tidal arms of Parengarenga Harbour and drifting sand from the Ninety Mile Beach.

This northernmost block is separated from the rest of the North Auckland Peninsula by a great tombolo, largely of drifting and consolidated sand, which extends fifty to sixty miles to the south-east to Ahipara and Awanui. The tombolo is flanked on the western side by the Ninety Mile Beach and on the eastern side by Great Exhibition Bay and Rangaunu Bay. These eastern bays are separated by high country around Mt. Camel, Houhora.

It is evident that at a not very remote time the northernmost block, the Mt. Camel area, and several smaller rocky outcrops, were islands lying off the remainder of the North Auckland Peninsula, and were comparable with the present isolation of the Three Kings group in respect to the mainland.

Several smaller tombolos indicate that the North Cape plateau was formerly an island, and in the west three contiguous small areas were separated from the main block by narrow waterways similar to that which now severs Cape Maria van Diemen Island from the main block. The formation of these small islands was evidently brought about by a considerable negative movement of the land (see Bartrum and Turner, 1928, Trans. N.Z. Inst. 59, p. 105).

The following restricted land molluscs with their southern equivalents point to long isolation of the northernmost block from the rest of the North Auckland Peninsula:—

| Northernmost Block. | Peninsula South of Awanui. |
|---|---|
| *Paryphanta watti* Powell, 1946 | *P. busbyi* (Gray, 1840) |
| *Rhytida duplicata* (Suter, 1904)<br>*Rhytida duplicata vivens* Powell, 1946 | *R. dunniae* (Gray, 1840) |
| *Allodiscus* n. sp. | *A. dimorphus* (Pfeiffer, 1853) |
| *Placostylus ambagiosus* Suter, 1906 | *P. hongii* (Lesson, 1830) |

The following is a belated attempt to piece together the distributional pattern of the *ambagiosus* group. Probably no other sparsely populated area in New Zealand has been subjected to such intensive burning, firstly by the Kauri Gum diggers and latterly by the younger Maoris, who still wantonly burn off large areas for no apparent reason. Except for a few isolated patches on high country, practically the whole of the area is now devoid of original forest cover.

The Maungapiko colony was greatly depleted by fire in February, 1946, only a few days before its discovery. The sand dunes of the northern coast at Cape Maria van Diemen, Spirits Bay and Tom Bowling Bay and Waikuku Beach on the east coast are strewn with vast numbers of bleached shells, but these colonies have been destroyed by natural causes. Increasing aridity since the Pleistocene has resulted in the dying out of all that coastal forest which formely grew upon sand.

The fact that sand will support stunted forest if the climate is sufficiently moist is demonstrated at Mason's Beach on the west coast of Stewart Island.

A further factor to be considered is that *Placostylus* never penetrates far inland, and since climatic changes have been more destructive to coastal vegetation than to inland areas, the present discontinuity of the *Placostylus* colonies is accounted for. This segregation of snail colonies into restricted areas is a prime factor in the evolution of new forms by isolation.

The natural causes that have brought about the differentiation of subspecific forms of *ambagiosus* are thus shown to be isolation of stock on small islands formed by a negative movement of the land, and increasing aridity since the Pleistocene. The human factor for historic times probably does not apply, since it has been merely destructive and sufficient time has not elapsed to affect colonies artificially segregated by fires.

On the other hand, pre-European influences cannot be ignored in respect to *Placostylus* populations, since many of the existing colonies are on headlands once occupied by Maoris. A significant fact is that the chief food plant of these snails, the karaka (*Corynocarpus laevigata*), was cultivated by the Maoris for food, and remains of these plantations are a conspicuous feature of most coastal pa sites north of Auckland.

That entirely natural segregation of *Placostylus* occurred prior to the advent of the Maori is shown herein by the geographically isolated subspecies found in consolidated dune deposits of presumed Pleistocene age.

Of the ten subspecific populations here described, *hinemoa*, *worthyi*, *priscus*, *lesleyae*, *spiritus* and *watti* are presumed to have developed in

situ free from human influence. Of the remainder, *ambagiosus* typical is obviously the recent insular descendant of *hinemoa*, and *annectens*, by its occupation of an area considerably larger than a Maori pa site (Unuwhao) within that area, would seem to be natural also, particularly as this subspecies does not show a dependence upon karaka, but is found associated with the generally distributed mahoe (*Melicytus ramiflorus*). The only subspecies that could owe their present location to Maori influence are *consobrinus*, which seems to have lived in historic times, and the still living *keenorum*. These populations could have resulted from stock intentionally or accidentally transported by the Maoris from nearby areas with karaka and flax plants, but this is unlikely since neither colony appears incongruous to its area.

The writer considers that at most the induced karaka plantations of the Maoris, so far as the northernmost block is concerned, merely gave a numerical impetus to *Placostylus* populations already naturally located. On the other hand, a number of colonies of *Placostylus hongii* on islands off the North Auckland east coast appear very definitely to be the result of Maori transportation.

Regarding the dune deposits of the northernmost block, it has often been stated that the *Placostylus* remains are concentrations from Maori cooking sites. The fact remains that most of the shells are entire and none show charring. Also an extinct snail, *Rhytida duplicata* Suter, 1904, and moa remains, often occur with the *Placostylus*.

Undoubtedly there is abundant evidence of Maori occupation on the dunes where the snail remains occur, but the apparent association is the result of a peculiarity of drifting dunes—the telescoping of prior stratification. The fine textured sand moves away by wind action, leaving all heavy objects in a surface layer.

The formation of the Waikuku Flat tombolo is of interest, for it enabled the subsequent spread of a subspecies which had originated through isolation on the North Cape block. However, the time factor coupled with increasing aridity did not allow this subspecies to spread beyond the tombolo to the main block.

In the Cape Maria van Diemen area at least two former islands are now linked by tombolos, but these have formed subsequent to the extinction of the snail colonies, which are found clear cut in situ with areas of sand without fossil snails occurring between.

## SPECIFIC CHARACTERS.

**1. Coloration.** The Cape Maria Island *ambagiosus* has a chestnut-brown epidermis, with a white subsutural band up to 1.5 mm. in width and a salmon-orange apertural callus.

The mainland living forms have a very dark reddish-brown epidermis with a narrow white subsutural band of 0.5 to 1.0 mm. in width, and a deep red to reddish-brown apertural callus.

Apertural colour still remaining in the extinct *consobrinus* indicates that it belonged to the dark reddish-brown series.

**2. Processes on the apertural callus.** There are five tubercles or thickened processes in full development. (See Powell, 1938, Rec.

Auck. Inst. Mus. 2 (3), p. 144.) No. 1 is a tubercle high on the outer lip, No. 2 a median tubercle with lateral extensions on outer lip, No. 3 a basal tubercle, No. 4 a thickened columellar fold and No. 5 a parietal tubercle.

In the following table the relative development of the apertural processes in the forms under review is given. 0 is absent, 1 weak, 2 moderate, and 3 strong.

| Apertural processes | 1. | 2. | 3. | 4. | 5. |
|---|---|---|---|---|---|
| *ambagiosus* | 2 | 2 | 3 | 1 | 1 |
| *hinemoa* | 2 | 1 | 3 | 1 | 2 |
| *worthyi* | 1 | 1 | 3 | 0 | 0 |
| *consobrinus* | 0 | 0 | 3 | 3 | 3 |
| *priscus* | 3 | 3 | 3 | 3 | 0 |
| *lesleyae* | 1 | 0 | 1 | 3 | 0 |
| *spiritus* | 2 | 2 | 3 | 1 | 0 |
| *keenorum* | 3 | 3 | 3 | 3 | 3 |
| *annectens* | 3 | 3 | 3 | 3 | 3 |
| *watti* | 3 | 3 | 3 | 3 | 3 |

## THE EGG.

The eggs, which are thin-shelled, white, with a buff-coloured cuticle, are deposited under leaf mould in cylindrical depressions of about one inch in diameter, and the same in depth. At Unuwhao (*annectens*) the nests contained from 15 to 18 eggs.

Examples of *annectens* kept in captivity by Mrs. I. Worthy, of Patumahoe, laid on 5th November, 1946, and hatched on 11th February, 1947, a period of incubation of 93 days.

The tables of dimensions of eggs given below indicate that there is considerable individual variation in size and proportions. However, the results do show that *ambagiosus* typical produces a long narrow egg and *ambagiosus annectens* a constantly larger and more globose egg.

| Species. | Length. | Diameter. | Av. Dimensions (in mm.) |
|---|---|---|---|
| *hongii* (Poor Knights Is.) | 6.00 | 5.00 | |
| | 6.00 | 5.00 | |
| | 6.00 | 5.10 | |
| | 5.60 | 4.70 | |
| | 5.60 | 4.50 | 5.84 x 4.86 |
| *ambagiosus ambagiosus* | 6.75 | 4.90 | |
| | 6.75 | 5.00 | |
| | 6.10 | 5.00 | |
| | 6.00 | 4.70 | |
| | 5.75 | 4.90 | 6.27 x 4.9 |

| Species. | Length. | Diameter. | Av. Dimensions (in mm.) |
|---|---|---|---|
| *ambagiosus keenorum* | 6.80 | 5.10 | |
| (West side) | 6.75 | 5.30 | |
| | 6.50 | 5.10 | |
| | 6.50 | 5.00 | |
| | 6.20 | 5.00 | 6.55 x 5.10 |
| (East side) | 6.10 | 5.00 | |
| | 6.10 | 5.10 | |
| | 6.00 | 5.30 | |
| | 6.00 | 4.90 | |
| | 5.75 | 5.40 | 5.99 x 5.14 |
| *ambagiosus spiritus* | 6.40 | 5.00 | |
| | 6.25 | 5.00 | |
| *ambagiosus annectens* | 7.30 | 5.75 | |
| | 6.90 | 5.70 | |
| | 6.60 | 5.75 | |
| | 6.40 | 5.80 | |
| | 6.40 | 5.30 | 6.72 x 5.66 |

## THE EMBRYONIC SHELL.

There is scarcely any difference between the embryonic shell of *ambagiosus* typical and that of *ambagiosus annectens* apart from the relative larger size of the latter, but they both differ from that of *hongii* in details of initial coiling and subsequent sculpture.

The radial ribbing of the first post-nuclear whorl in *hongii* is evenly sigmoid, but in *ambagiosus* it changes abruptly in inclination six times, so that the ribs have a zig-zag recurrent trend. The initial coiling in *hongii* shows the tip to be gently incurved and slightly immersed in a shallow pit, but in *ambagiosus* the initial whorl is much more deeply immersed and it bends inward at so sharp an angle that a raised narrow shoulder projects to form the actual tip above a deep narrow cleft. On the later whorls of the protoconch the ribbing tends to become evenly arcuate in both species. The radials stop abruptly at the periphery except for faint radial growth lines. The base is devoid of spiral sculpture in *hongii*, but has faint punctate spiral lines in both *ambagiosus* and *ambagiosus annectens*.

## KEY TO SUBSPECIES.

Diagramatic representations of the shells are introduced in place of the conventional descriptive key (see folder plate). These show relative dimensions, adult size range, height of aperture, spire angle and the apertural-process formula. Visual comparison is afforded and, since the diagrams are reproduced actual size, specimens may be placed upon the diagrams for determining proportion and spire angle.

*Note*: Overall dimensions, especially diameter, are deceptive to the eye, appearing greater than they actually are, so place the shell with the axis vertical and in parallel plane with the diagram. The aperture, also, should be in parallel plane. Use a right-angled set-square to line up the shell with the diagram. The heavy continuous lined rectangles represent average height and diameter and the larger and smaller dotted rectangles the greatest and least dimensions respectively. The cross bar denotes average height of the peristome. Similarly, the average spire angle is the heavy continuous line, and greatest and least angles are the additional dotted lines.

In matching shells for spire angle take the profile of the post-nuclear whorls, excluding the protoconch, which on account of its bluntly conic shape shows a much broader angle than for the rest of the spire.

The circles of figures refer to the relative strengths of the five apertural processes in the order of 0-3 (see preceding table). In using the diagrammatic key the suggested procedure is: (1) match approximately for dimensions, (2) determine spire angle, (3) check apertural processes.

The tables are compilations of the measurements of ten specimens, so individual variation must be allowed for—an example showing maximum diameter is not likely to have maximum height also.

## TABLES OF DIMENSIONS.

The following tables record the individual characteristics of fourteen colonies of snails. Ten examples were chosen from each lot with the exception of two localities where less than that number were collected. For most localities 50-100 examples were available. The only selective action was to discard malformations and to ensure that both the largest and the smallest adult for each locality was included; the rest were taken at random.

Column (1) gives the height, (2) the diameter, (3) the outside height of the apertural callus from the suture to the basal lip, (4) the spire ratio, being the total height divided by the apertural callus height, and (5) is the angle of the spire. The two initial whorls are ignored in estimating this angle.

1. *ambagiosus ambagiosus* Suter, 1946.

| Ht. | Diam. | Ap. ht. | Sp. ratio. | Sp. ang. |
|---|---|---|---|---|
| 77.75 | 33.00 | 34.50 | 2.251 | 45° |
| 77.00 | 32.00 | 35.00 | 2.200 | 50° |
| 75.00 | 31.50 | 34.00 | 2.205 | 50° |
| 75.00 | 32.50 | 36.00 | 2.083 | 50° |
| 74.00 | 32.00 | 36.00 | 2.055 | 50° |
| 72.50 | 33.50 | 37.00 | 1.959 | 50° |
| 72.00 | 31.50 | 35.00 | 2.057 | 50° |
| 70.50 | 30.00 | 33.50 | 2.104 | 49° |
| 70.50 | 31.00 | 33.00 | 2.136 | 49° |
| 69.50 | 31.00 | 32.50 | 2.138 | 50° |

| | Ht. | Diam. | Ap. ht. | Sp. ratio. | Sp. ang. |
|---|---|---|---|---|---|
| 2. *ambagiosus hinemoa* n. subsp. | | | | | |
| | 82.00 | 36.00 | 39.50 | 2.076 | 50° |
| | 80.00 | 36.00 | 40.00 | 2.000 | 50° |
| | 78.00 | 36.00 | 37.50 | 2.080 | 53° |
| | 78.00 | 36.00 | 37.00 | 2.108 | 57° |
| | 75.50 | 37.50 | 38.00 | 1.986 | 58° |
| | 74.00 | 36.00 | 38.00 | 1.947 | 62° |
| | 74.00 | 35.00 | 37.00 | 2.000 | 60° |
| | 71.75 | 34.00 | 34.50 | 2.079 | 54° |
| | 69.00 | 31.00 | 32.50 | 2.123 | 50° |
| | 68.50 | 31.50 | 33.00 | 2.057 | 53° |
| 3. *ambagiosus worthyi* n. subsp. | | | | | |
| | 75.50 | 34.50 | 38.00 | 1.961 | 54° |
| | 70.50 | 31.00 | 33.00 | 2.136 | 49° |
| | 69.00 | 33.50 | 36.00 | 1.916 | 51° |
| | 68.50 | 30.00 | 32.50 | 2.107 | 50° |
| | 68.00 | 27.50 | 30.00 | 2.266 | 50° |
| | 64.00 | 28.00 | 29.00 | 2.206 | 50° |
| | 63.50 | 30.00 | 31.50 | 2.015 | 50° |
| | 62.00 | 27.50 | 29.00 | 2.137 | 50° |
| | 61.50 | 26.00 | 27.50 | 2.236 | 50° |
| | 57.50 | 26.00 | 28.00 | 2.053 | 53° |
| 4. *ambagiosus consobrinus* Powell, 1938. | | | | | |
| | 86.00 | 37.00 | 37.00 | 2.324 | 46° |
| | 81.00 | 35.00 | 35.00 | 2.314 | 47° |
| | 80.00 | 34.50 | 34.50 | 2.318 | 46° |
| | 79.50 | 34.00 | 34.00 | 2.338 | 44° |
| | 79.00 | 35.00 | 35.00 | 2.257 | 45° |
| | 79.00 | 35.00 | 35.00 | 2.257 | 47° |
| | 76.50 | 34.50 | 34.50 | 2.217 | 46° |
| | 73.50 | 32.50 | 32.50 | 2.567 | 47° |
| | 71.00 | 32.00 | 32.00 | 2.218 | 44° |
| | 70.50 | 30.50 | 30.50 | 2.311 | 46° |
| 5. *ambagiosus priscus* Powell, 1938. | | | | | |
| | 81.50 | 33.00 | 37.00 | 2.202 | 49° |
| | 77.00 | 31.00 | 37.00 | 2.081 | 44° |
| | 76.50 | 31.00 | 36.00 | 2.125 | 45° |
| | 75.50 | 31.00 | 36.50 | 2.068 | 47° |
| | 75.00 | 31.50 | 36.00 | 2.083 | 49° |
| | 75.00 | 31.00 | 35.00 | 2.142 | 48° |
| | 75.00 | 32.00 | 35.00 | 2.142 | 47° |
| | 74.00 | 29.50 | 34.00 | 2.176 | 48° |
| | 74.00 | 29.00 | 35.00 | 2.114 | 46° |
| | 74.00 | 32.00 | 36.00 | 2.055 | 47° |

| | Ht. | Diam. | Ap. ht. | Sp. ratio. | Sp. ang. |
|---|---|---|---|---|---|
| 6. *ambagiosus lesleyae* n. subsp. | | | | | |
| | 83.00 | 35.00 | 29.00 | 2.128 | 49° |
| | 80.00 | 36.00 | 39.00 | 2.051 | 50° |
| | 79.00 | 32.50 | 37.00 | 2.135 | 49° |
| | 77.00 | 33.00 | 38.00 | 2.333 | 50° |
| | 75.00 | 32.50 | 35.50 | 2.112 | 50° |
| | 75.00 | 33.00 | 35.50 | 2.112 | 51° |
| | 74.50 | 33.00 | 36.00 | 2.069 | 50° |
| | 74.00 | 31.00 | 34.50 | 2.113 | 49° |
| | 73.50 | 32.00 | 35.00 | 2.100 | 51° |
| | 72.50 | 32.50 | 37.00 | 1.959 | 51° |
| 7. *ambagiosus spiritus* n. subsp. | | | | | |
| | 75.00 | 29.50 | 33.00 | 2.272 | 48° |
| | 75.00 | 32.50 | 35.50 | 2.112 | 50° |
| | 72.75 | 31.00 | 34.50 | 2.108 | 50° |
| | 70.00 | 29.00 | 33.00 | 2.121 | 46° |
| | 70.00 | 30.00 | 32.50 | 2.153 | 47° |
| | 68.50 | 30.00 | 32.00 | 2.140 | 50° |
| | 68.00 | 30.50 | 31.00 | 2.193 | 47° |
| | 68.00 | 29.00 | 31.50 | 2.158 | 47° |
| | 66.00 | 28.50 | 31.00 | 2.129 | 48° |
| | 65.00 | 28.50 | 31.00 | 2.096 | 46° |
| 8. *ambagiosus keenorum* n. subsp. (Maungapiko, west side). | | | | | |
| | 84.00 | 35.00 | 39.50 | 2.126 | 42° |
| | 83.30 | 35.00 | 41.00 | 2.031 | 44° |
| | 79.00 | 34.00 | 37.50 | 2.106 | 45° |
| | 76.50 | 33.00 | 38.50 | 1.987 | 46° |
| | 76.00 | 31.00 | 36.00 | 2.111 | 41° |
| | 75.75 | 31.00 | 34.50 | 2.195 | 42° |
| | 75.50 | 32.00 | 35.50 | 2.126 | 46° |
| | 75.00 | 30.00 | 35.00 | 2.140 | 40° |
| | 71.75 | 30.50 | 35.50 | 2.021 | 42° |
| | 70.25 | 28.00 | 34.00 | 2.066 | 40° |
| | | (Maungapiko, east side) | | | |
| | 81.00 | 32.00 | 37.00 | 2.189 | 40° |
| | 80.25 | 32.50 | 38.00 | 2.112 | 40° |
| | 80.00 | 33.00 | 38.00 | 2.105 | 39° |
| | 79.50 | 32.00 | 36.50 | 2.178 | 40° |
| | 79.00 | 31.00 | 37.00 | 2.138 | 35° |
| | 78.50 | 30.50 | 37.00 | 2.122 | 40° |
| | 77.25 | 29.50 | 35.00 | 2.207 | 36° |
| | 77.00 | 33.00 | 38.00 | 2.026 | 40° |
| | 77.00 | 31.00 | 35.50 | 2.169 | 40° |
| | 76.50 | 31.00 | 36.00 | 2.125 | 39° |

| | Ht. | Diam. | Ap. ht. | Sp. ratio. | Sp. ang. |
|---|---|---|---|---|---|
| 9. *ambagiosus annectens* Powell, 1938. (Unuwhao; type loc.) | | | | | |
| | 95.00 | 40.00 | 46.00 | 2.065 | 50° |
| | 94.00 | 40.00 | 46.00 | 2.043 | 49° |
| | 94.00 | 41.00 | 45.00 | 2.088 | 50° |
| | 90.00 | 39.00 | 45.00 | 2.000 | 50° |
| | 90.00 | 37.50 | 43.00 | 2.093 | 49° |
| | 89.00 | 38.00 | 43.00 | 2.069 | 51° |
| | 88.00 | 38.50 | 41.00 | 2.148 | 49° |
| | 87.00 | 39.00 | 44.00 | 1.977 | 50° |
| | 86.75 | 40.00 | 45.00 | 1.927 | 50° |
| | 86.50 | 36.00 | 40.00 | 2.162 | 50° |
| (Unuwhao; coast ridge) | | | | | |
| | 88.75 | 38.50 | 42.00 | 2.113 | 49° |
| | 88.50 | 37.00 | 41.00 | 2.158 | 49° |
| | 88.00 | 37.00 | 41.00 | 2.146 | 49° |
| | 88.00 | 37.50 | 41.50 | 2.120 | 50° |
| | 87.00 | 38.00 | 42.00 | 2.071 | 51° |
| | 86.76 | 38.00 | 40.50 | 2.142 | 49° |
| | 82.25 | 37.00 | 40.00 | 2.056 | 51° |
| 10. *ambagiosus watti* n. subsp. (Recent. Type loc.) | | | | | |
| | 86.00 | 39.00 | 43.00 | 2.000 | 51° |
| | 83.00 | 39.00 | 43.00 | 1.930 | 51° |
| | 81.00 | 36.50 | 39.00 | 2.076 | 50° |
| | 80.50 | 39.00 | 40.00 | 2.012 | 51° |
| | 80.25 | 37.50 | 42.00 | 1.911 | 51° |
| | 79.00 | 34.50 | 38.00 | 2.078 | 50° |
| | 77.50 | 35.00 | 38.50 | 2.013 | 50° |
| | 76.00 | 34.00 | 38.00 | 2.000 | 51° |
| (Subrecent, Tom Bowling Bay) | | | | | |
| | 83.50 | 35.00 | 40.00 | 2.087 | 50° |
| | 81.00 | 33.50 | 36.50 | 2.219 | 51° |
| | 80.50 | 35.00 | 39.50 | 2.038 | 50° |
| | 80.00 | 35.00 | 37.50 | 2.133 | 50° |
| | 80.00 | 34.50 | 37.00 | 2.162 | 51° |
| | 79.00 | 35.00 | 38.50 | 2.052 | 50° |
| | 78.75 | 35.00 | 38.50 | 2.045 | 51° |
| | 77.50 | 32.50 | 36.00 | 2.152 | 50° |
| | 77.00 | 33.00 | 38.00 | 2.026 | 49° |
| | 71.00 | 32.00 | 34.00 | 2.088 | 50° |
| (Subrecent, Waikuku Beach) | | | | | |
| | 81.00 | 35.00 | 39.00 | 2.077 | 50° |
| | 81.00 | 32.00 | 37.00 | 2.189 | 48° |
| | 81.00 | 35.50 | 40.00 | 2.025 | 50° |
| | 79.50 | 33.00 | 36.00 | 2.208 | 49° |
| | 77.50 | 33.00 | 36.75 | 2.108 | 50° |
| | 76.50 | 32.50 | 36.00 | 2.125 | 50° |
| | 76.25 | 32.50 | 37.50 | 2.033 | 52° |
| | 76.00 | 35.00 | 39.00 | 1.948 | 55° |
| | 75.00 | 32.50 | 37.00 | 2.027 | 49° |
| | 74.00 | 33.00 | 38.00 | 2.242 | 54° |

## PLACOSTYLUS Beck, 1837.

## MAORISTYLUS Haas, 1935.

Type (o.d.): BULIMUS SHONGII Lesson.

### Placostylus (Maoristylus) ambagiosus Suter, 1906.

1906 *Placostylus hongii ambagiosus* Suter, Journ. de Conch. Paris, 54, p. 253. Pl. 8.

1913 *Placostylus hongii ambagiosus* Suter, Man. N.Z. Moll., p. 768; not Suter, 1915, Atlas, Pl. 48, f. 15.

1938 *Placostylus ambagiosus Powell*, Rec. Auck. Inst. Mus 1 (3), p. 147, Pl. 34, f. 1.

*Type locality:* Cape Maria van Diemen (Island).

### 1. Placostylus (Maoristylus) ambagiosus ambagiosus Suter, 1906. Pl. 20, figs. 1-3.

*Dimensions:*

| | | | | |
|---|---|---|---|---|
| Average ht. 73.37 mm., | diam. 31.80 mm., | ap. ht. 34.65 mm., | sp. ang. 49.3° |
| Greatest ht. 77.75 mm., | diam. 33.50 mm., | ap. ht. 37.00 mm., | sp. ang. 50° |
| Least ht. 69 50 mm., | diam. 30.00 mm., | ap. ht. 32.50 mm., | sp. ang. 45° |

*Apertural processes:* 2 2 3 1 1

*Coloration.*—Epidermis: Ochraceous-tawny and russet to Mars brown, with a wide subsutural white margining.
Aperture: Salmon-orange.*

*Locality:* Cape Maria van Diemen Island, Recent (type). Small colonies still exist around the roots of flax (*Phormium*) on the south-west cliff face; Mr. F. Young, May, 1934. The island is of 411 feet elevation and is sparsely clothed with flax (*Phormium*) and stunted trees and scrub. It is separated from the mainland by a deep-water channel of ¾ mile in width.

*Remarks:* The typical species is restricted to the island and is distinguished from all the mainland subspecies by its lighter brown epidermis with a 1.5 mm. white subsutural margining, and salmon-orange apertural callus.

*Holotype:* In the H. Suter collection, N.Z. Geological Survey, Wellington. 74 mm. x 33 mm.

### 2. Placostylus (Maoristylus) ambagiosus hinemoa, n. subsp. Pl. 20, figs 4-6.

*Dimensions:*

| | | | |
|---|---|---|---|
| Average ht. 75.07 mm., | diam. 34.85 mm., | ap. ht. 36.70 mm , | sp. ang. 54.7° |
| Greatest ht. 82.00 mm., | diam. 37.50 mm , | ap. ht. 40.00 mm., | sp. ang. 62° |
| Least ht. 68.50 mm., | diam. 31.00 mm., | ap. ht. 32.50 mm., | sp. ang. 50° |

*Apertural processes:* 2 1 3 1 2

*Locality:* Cape Maria van Diemen Island in consolidated sand-dunes presumably of Pleistocene age. Captain J. Bollons, 1924, and Mr. F. Young, 1934.

* All colour references are from Ridgway, 1912. Colour Standards and Colour Nomenclature.

*Remarks:* Compared with the typical subspecies, *hinemoa* is of much heavier build, is proportionately broader and has a wider spire angle. The subspecies is named in memory of the former Government steamer and lighthouse tender "Hinemoa."

*Holotype:* In the writer's collection, Auckland Museum. 75.7 mm. x 37.5 mm.

### 3. **Placostylus (Maoristylus) ambagiosus worthyi** n. subsp. Pl. 20, figs. 7-9.

*Dimensions:*

| | | | | |
|---|---|---|---|---|
| Average ht. | 66.00 mm., | diam. 29.40 mm., | ap. ht. 31.45 mm., | sp. ang. 50.7° |
| Greatest ht. | 75.50 mm., | diam. 34.50 mm., | ap. ht. 38.00 mm., | sp. ang. 54° |
| Least ht. | 57.50 mm , | diam. 26.00 mm., | ap. ht. 27.50 mm., | sp. ang. 49° |

*Apertural processes:* 1 1 3 0 0

*Coloration.*—Apertural colour in freshly excavated examples is not sufficiently intense to determine if the original colour linked them with the salmon-orange typical species of the island or the dark-red mainland series.

*Locality:* In consolidated sand-dunes, presumably of Pleistocene age, on the north-eastern side of the extreme north-western Cape Maria van Diemen mainland. Large numbers of weathered shells are to be found loose in the superimposed Recent drifting dunes. Examples dug from the consolidated dunes still exhibit traces of apertural colour. The visible area occupied by this subspecies is about one acre. Messrs. E. T. B. Worthy, A. C. O'Connor, and A. W. B. Powell, February, 1946.

*Remarks:* This subspecies is the smallest of the series. In shape it more closely resembles the typical Recent species than its contemporary, the island fossil subspecies *hinemoa*. Apart from small size, the main differentiating feature of *worthyi* is the poorly developed apertural processes, for only the basal tubercle 3, is prominent Even in obviously senile examples these characters remain constant.

The extreme north-western headland, where these snails, and the following form, *consobrinus*, occur, is obviously a former island now tied to the mainland by a tombolo. A belt of drifting sand from half to three-quarters of a mile in width, which is devoid of fossil snails, indicates the prior existence of a waterway similar to the one which now separates the north-western headland from Cape Maria van Diemen Island. This former waterway was obviously the factor which operated in the segregation of *worthyi* from *priscus*.

*Holotype:* In Auckland Museum. 63.25 mm. x 29.50 mm.

### 4. **Placostylus (Maoristylus) ambagiosus consobrinus** Powell, 1938. Pl. 20, figs. 10-12.

1938 *Placostylus ambagiosus consobrinus* Powell. Rec. Auck. Inst. Mus. 1 (3), p. 149, Pl. 34, f. 7, 8.

*Dimensions:*

| | | | | |
|---|---|---|---|---|
| Average ht. | 77.60 mm., | diam. 34.00 mm., | ap. ht. 34 00 mm., | sp. ang. 45.8° |
| Greatest ht. | 86.00 mm., | diam. 37.00 mm., | ap. ht. 37.00 mm., | sp. ang. 47° |
| Least ht. | 70 50 mm., | diam. 30.50 mm., | ap. ht. 30.50 mm., | sp. ang. 44° |

*Apertural processes:* 0 0 3 3 3

*Coloration.*—Most examples have strong apertural colour indicating the subspecies as one of the mainland reddish-brown series.

*Locality:* In Recent loose sand-dunes on the north-eastern side of the extreme north-western Cape Maria van Deimen mainland. A. W. B. Powell, February, 1932, and February, 1946.

*Remarks:* This is the most distinctive of all the subspecies. It is readily recognised by the relatively small aperture and the invariable fact that the height of the aperture equals the major diameter of the shell. In all other forms the apertural height is greater than the diameter of the shell. The apertural processes are of distinctive arrangement also, with the first two tubercles obsolete and numbers 3, 4 and 5 well developed.

It seems likely that this form became extinct within comparatively Recent times, for it is found associated with the outermost fringe of flax at the junction between the rough pasture of the headland and the drifting sand.

On the occasion of the 1946 visit very few *consobrinus* were to be found, and indications are that the colony never was extensive.

*Holotype:* In Auckland Museum. 79 mm. x 35 mm.

### 5. **Placostylus (Maoristylus) ambagiosus priscus** Powell, 1938. Pl. 21, figs. 1-3.

1938 *Placostylus ambagiosus priscus* Powell, Rec. Auck. Inst. Mus. 1 (3), p. 149, Pl. 34, f. 9, 10.

*Dimensions:*

| | | | | |
|---|---|---|---|---|
| Average ht. | 75.75 mm., | diam. 31.10 mm , | ap. ht. 35.75 mm., | sp. ang. 47° |
| Greatest ht. | 81.50 mm., | diam. 33.00 mm., | ap. ht. 37.00 mm , | sp. ang. 49° |
| Least ht. | 74.00 mm., | diam. 29.00 mm., | ap. ht. 34.00 mm., | sp. ang. 44° |

*Apertural processes:* 3 3 3 3 0

*Locality:* In consolidated sand-dunes of presumed Pleistocene age commencing on rising ground about three-quarters of a mile east of the extreme north-western headland and bearing north-east to the highest land in the vicinity—a hill of 700 feet which is capped with flax, toetoe, and stunted pohutukawa. From this hill further exposures of these snails either in situ or derived in recent drift-sand occur both to the north almost down to sea level and to the east towards Te Werahi Stream and Te Werahi Swamp, which formed, no doubt, the eastern boundary of the colony. A. W. B. Powell, February, 1932, and February, 1946.

*Remarks:* This subspecies is distinguished by its narrow spire angle, laterally compressed body-whorl, and oblique, long, and comparatively narrow aperture. The apertural processes are all strong with the exception of number five, which is absent.

That the area was once clothed with dense rain forest is shown by the associated fossil land molluscs: *Paryphanta watti*, *Rhytida duplicata*, *Serpho kivi*, *Gerontia cordelia* and *Liarea* n. sp.

*Holotype:* In Auckland Museum. 77 mm. x 31 mm.

### 6. **Placostylus (Maoristylus) ambagiosus lesleyae** n. subsp. Pl. 21, figs. 4-6.

*Dimensions:*

| | | | | |
|---|---|---|---|---|
| Average ht | 76.35 mm., | diam. 33.05 mm., | ap. ht. 36.65 mm., | sp. ang. 50° |
| Greatest ht. | 83.00 mm., | diam. 36.00 mm., | ap. ht. 39.00 mm., | sp. ang. 51° |
| Least ht. | 72.00 mm , | diam. 31.00 mm., | ap. ht. 34.50 mm., | sp. ang. 49° |

*Apertural processes:* 1 0 1 3 0

*Locality:* Taputaputa Bay, east of Cape Te Reinga. Collected by Miss Lesley Keene, April, 1946. The specimens were apparently from recently exposed consolidated dunes underlying Recent drifting dunes. The writer failed to locate any specimens at this locality in February, 1932.

*Remarks:* On shell proportions this subspecies closely resembles typical *ambagiosus*, but it attains slightly larger size and has distinctive apertural features. No. 3 tubercle, the most persistent one in all the other subspecies, is in *lesleyae* relatively weak and tends, together with numbers 1 and 2, to become obsolete. The most prominent process is No. 4, the thickened columellar fold, which is stronger than in any other subspecies. In fully adult and senile examples the apertural callus becomes uniformly thickened and reflexed at the outer edge.

There is no indication of former distributional extent of this subspecies beyond the type locality.

*Holotype:* In Auckland Museum. 74.5 mm. x 33.2 mm.

### 7. **Placostylus (Maoristylus) ambagiosus spiritus** n. subsp. Pl. 21, figs 7-9.

*Dimensions:*

| | | | | |
|---|---|---|---|---|
| Average ht. | 69.92 mm., | diam. 29.85 mm., | ap. ht. 32.50 mm., | sp. ang. 47.9° |
| Greatest ht. | 75.00 mm., | diam. 32.50 mm., | ap. ht. 35.50 mm., | sp. ang. 50° |
| Least ht. | 65.00 mm., | diam. 28.50 mm., | ap. ht. 31.00 mm., | sp. ang. 46° |

*Apertural processes:* 2 2 3 1 0

*Locality:* In loose sand-dunes at Spirits Bay, two to three miles east of Pandora. A W. B. Powell, February, 1932.

*Holotype:* In Auckland Museum. 68.7 mm. x 29.5 mm.

*Remarks:* This is a dwarf form comparable with *worthyi* in size and shape, but having more developed apertural processes, the basal tubercle being particularly strong. It is a near relative to the next subspecies, *keenorum*, from Maungapiko, at the north-eastern end of Spirits Bay.

Since the above was written Mr. R. H. Michie, of Kaitaia located a living colony a short distance west of Pandora. This colony has survived on the stable terrain, but only subfossil examples remain at the type locality on the drifting dunes. The dimensions, spire-angle and apertural processes come within the range for the type series. The coloration and narrow subsutural band are exactly as in the next subspecies, *keenorum*.

A bleached shell showing apertural colour and two fragments were found by the writer in February, 1946, at 800 feet on the eastern side of Kahuronaki (Kahuroa on survey maps), which lies about three miles south of Spirits Bay and between Te Paki and Te Hapua. This form measures 78 mm. x 35 mm, and probably represents still another subspecies. Kahuronaki is one of the few localities in the northernmost block that still carries original forest cover. A further search may result in the finding of living colonies in this vicinity.

## 8. **Placostylus (Maoristylus) ambagiosus keenorum** n. subsp. Pl. 22, figs 1-5.

*Dimensions* (East Side Colony):

| | | | | |
|---|---|---|---|---|
| Average ht. | 78.60 mm., | diam. 31.55 mm., | ap. ht. 36.80 mm., | sp. ang. 38.9° |
| Greatest ht. | 81.00 mm., | diam. 33.00 mm., | ap. ht. 38.00 mm., | sp. ang. 40° |
| Least ht. | 76.50 mm, | diam. 29.50 mm., | ap. ht. 35.00 mm., | sp. ang. 35° |

(West Side Colony):

| | | | | |
|---|---|---|---|---|
| Average ht. | 76.70 mm., | diam. 31.95 mm., | ap. ht. 36.70 mm., | sp. ang. 42.8° |
| Greatest ht. | 84.00 mm., | diam. 35.00 mm., | ap. ht. 41.00 mm., | sp. ang. 46° |
| Least ht. | 70.25 mm., | diam. 28.00 mm., | ap. ht. 34.00 mm., | sp. ang. 40° |

*Apertural processes*: 3 3 3 3 3

*Coloration.*—Epidermis: Russet to Mars brown, diffused with dark warm-sepia. White subsutural margining very narrow.
Aperture: Deep red-brown within and light ochraceous-salmon on reflected edge of peristome.

*Localities:* Two almost continuous colonies on the eastern (type) and western slopes, respectively of Maungapiko, at 50-150 feet, eastern end of Spirits Bay. A. C. O'Connor, E. T. B. Worthy, and the writer, February, 1946.

*Remarks:* This subspecies is easily recognised by its slender shape, which results in the narrowest spire angle of the group, and an aperture considerably higher than wide. All five apertural processes are fully developed and the coloration is identical with that of the much larger and broader *annectens* from three to four miles to the south-east at 800-900 feet.

The eastern and western colonies respectively exhibit a slight difference in spire angle. Those from the western side have on the whole a slightly greater angle. Considering that the two colonies must have had a continuous distribution around Maungapiko at a comparatively recent date, this difference in spire angle is remarkable. It cannot be explained as the result of isolation, but would seem to be ecological, for those on the east side have warmer conditions and a greater abundance of food (leaves of the karaka tree). More rapid growth could conceivably result in whorl acceleration, although the largest subspecies, *annectens*, from the high forested ridges around Unuwhao, have achieved large size without abnormal acceleration of the whorls. Examples of *hongii* from the Poor Knights Islands kept in captivity made no growth during the winter months. This fact may have a bearing upon the Maungapiko colonies, since those on the warm eastern side compared with those on the cooler western side should have a longer annual period suited to growth.

The colonies are clustered around the roots of fern, *Carex* and amongst flax (*Phormium*) wherever their food tree, the karaka, is present. Unfortunately, an extensive scrub fire in January, 1946, destroyed hundreds of these snails and reduced both colonies to such an extent that it is doubtful if they will long survive.

The figures of juveniles of both *keenorum* and *annectens* (Pl. 17, figs 3 and 8) show the differences in proportions to be even more marked than in adults. An example of *keenorum* (east side) has the peristome just formed at 79.25 mm. in height, whereas this stage obtains in *annectens* at 87.50 mm.

The subspecies is named in recognition of hospitality extended to the writer on several occasions by Mr. and Mrs. L. Keene, of Te Paki.

*Holotype:* From Maungapiko, east side, in Auckland Museum. 80.7 mm. x 32.6 mm.

### 9. **Placostylus (Maoristylus) ambagiosus annectens** Powell, 1938. Pl. 22, figs 6-9.

1938 *Placostylus ambagiosus annectens* Powell, Rec. Auck. Inst. Mus. 2 (3), p. 148, Pl. 34, f. 2-6.

*Dimensions:*

Average ht. 90.02 mm., diam. 38.90 mm., ap. ht. 43.80 mm., sp. ang. 49.8°
Greatest ht. 95.00 mm., diam. 41.00 mm., ap. ht. 46.00 mm., sp. ang. 51.0°
Least ht. 86.50 mm., diam. 36.00 mm., ap. ht. 40.00 mm., sp. ang. 49.0°

*Apertural processes:* 3 3 3 3 3

*Coloration.*—Epidermis: Russet to Mars brown, diffused with dark warm-sepia. White subsutural margining very narrow.
Aperture: Deep red-brown within and light ochraceous salmon on reflected edge of peristome.

*Localities:* Unuwhao, 900 feet, on track between Spirits Bay and Tom Bowling Bay (type); coastal ridge north of type locality and connected with Unuwhao by a horseshoe-shaped narrow ridge, now deforested. A. W. B. Powell, February, 1932, and February, 1946.

*Remarks:* This is the largest subspecies. In proportions it is nearest to the following subspecies, *watti*, but in coloration it is identical with *keenorum*. It lives only near the crest of ridges in rain forest at from 700 to 900 feet, and occurs around clumps of *Carex* and under fallen leaves. It is seldom found at more than 30 feet below the crest of a ridge. The chief food plant is mahoe, for karaka is scarce at Unuwhao.

*Holotype:* In Auckland Museum. 94 mm. x 40 mm.

### 10. **Placostylus (Maoristylus) ambagiosus watti** n. subsp. Pl. 22, figs. 10-13.

*Dimensions:*

*Recent (type locality):*
Average ht. 80.40 mm., diam. 36.81 mm., ap. ht. 40.18 mm., sp. ang. 50.625°
Greatest ht. 86.00 mm., diam. 39.00 mm., ap. ht. 43.00 mm., sp. ang. 51°
Least ht. 76.00 mm., diam. 34.00 mm., ap. ht. 38.00 mm., sp. ang. 50°

*Subrecent (drifting dunes, Tom Bowling Bay):*
Average ht. 78 85 mm., diam. 34.05 mm., ap. ht. 37.55 mm., sp. ang. 50.2°
Greatest ht. 83.50 mm., diam. 35.00 mm., ap. ht. 40.00 mm., sp. ang. 51°
Least ht. 71.00 mm, diam. 32.00 mm., ap. ht. 34.00 mm., sp. ang. 49°

*Subrecent (drifting dunes, Waikuku):*
Average ht. 77.77 mm., diam. 33.40 mm., ap. ht. 37.62 mm., sp. ang. 50.7°
Greatest ht. 81.00 mm., diam. 35.50 mm., ap. ht. 40.00 mm., sp. ang. 55°
Least ht. 74 00 mm., diam. 32.00 mm., ap. ht. 36.00 mm., sp. ang. 48°

*Apertural processes:* 3 3 3 3 3

*Coloration.*—Epidermis: Antique brown, auburn to bay. White subsutural margining narrow.
Aperture: Mars orange to Sanford's brown within, tinged with deep red-brown towards the apertural processes and fading to light ochraceous salmon on the reflected edge of the peristome.

*Localities:* Midway between Waikuku Beach and North Cape Lighthouse, 10-30 feet elevation and from 25 to 200 feet back from the boulder-strewn beach. Recent (type). They occur either around *Carex*, under karaka and pohutukawa, or under flax (*Phormium*) within the leaf fall area of individual karaka trees; Tom Bowling Bay, subrecent in loose dunes; Waikuku Beach, subrecent in loose dunes. A. W. B. Powell, December, 1945.

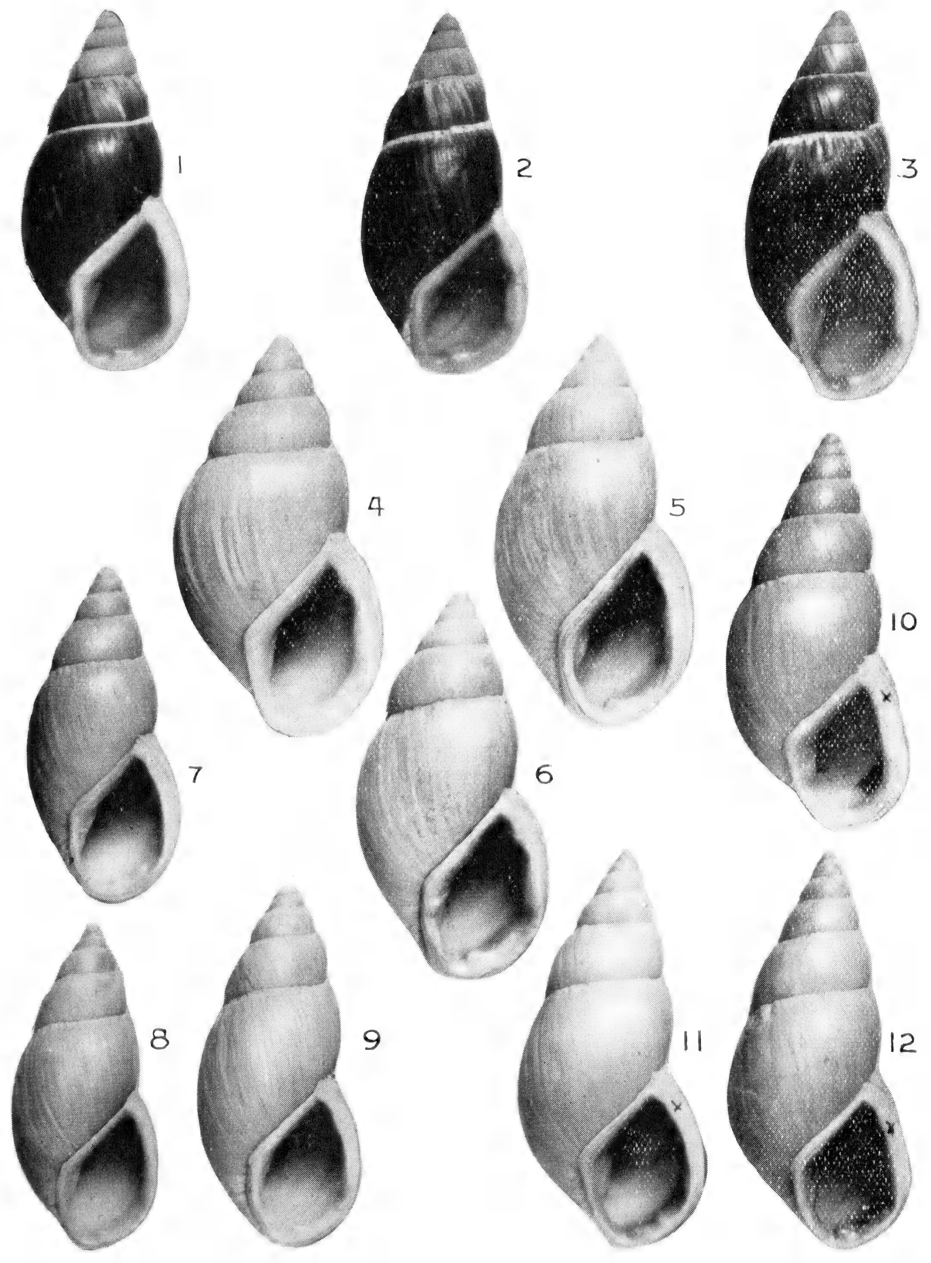
*Holotype:* In Auckland Museum. 81 mm. x 36 mm.

*Remarks:* This subspecies is very close to *annectens*, but it is constantly of smaller adult size and the epidermis is paler and more reddish-brown without the diffused dark warm-sepia. It should be noted that the largest examples of *watti* are senile, yet they are smaller than an immature *annectens* with the peristome just formed, that is at 87.50 mm. The North Cape subspecies evidently became differentiated through isolation prior to the linking of that area to the mainland with the formation of a tombolo known as the Waikuku Flat. After the formation of the tombolo, dunes heaped up on the north flank at Tom Bowling Bay and on the eastern side at Waikuku Beach. Both these dune formations are littered with the bleached shells of a *Placostylus* which seems inseparable from *watti*.

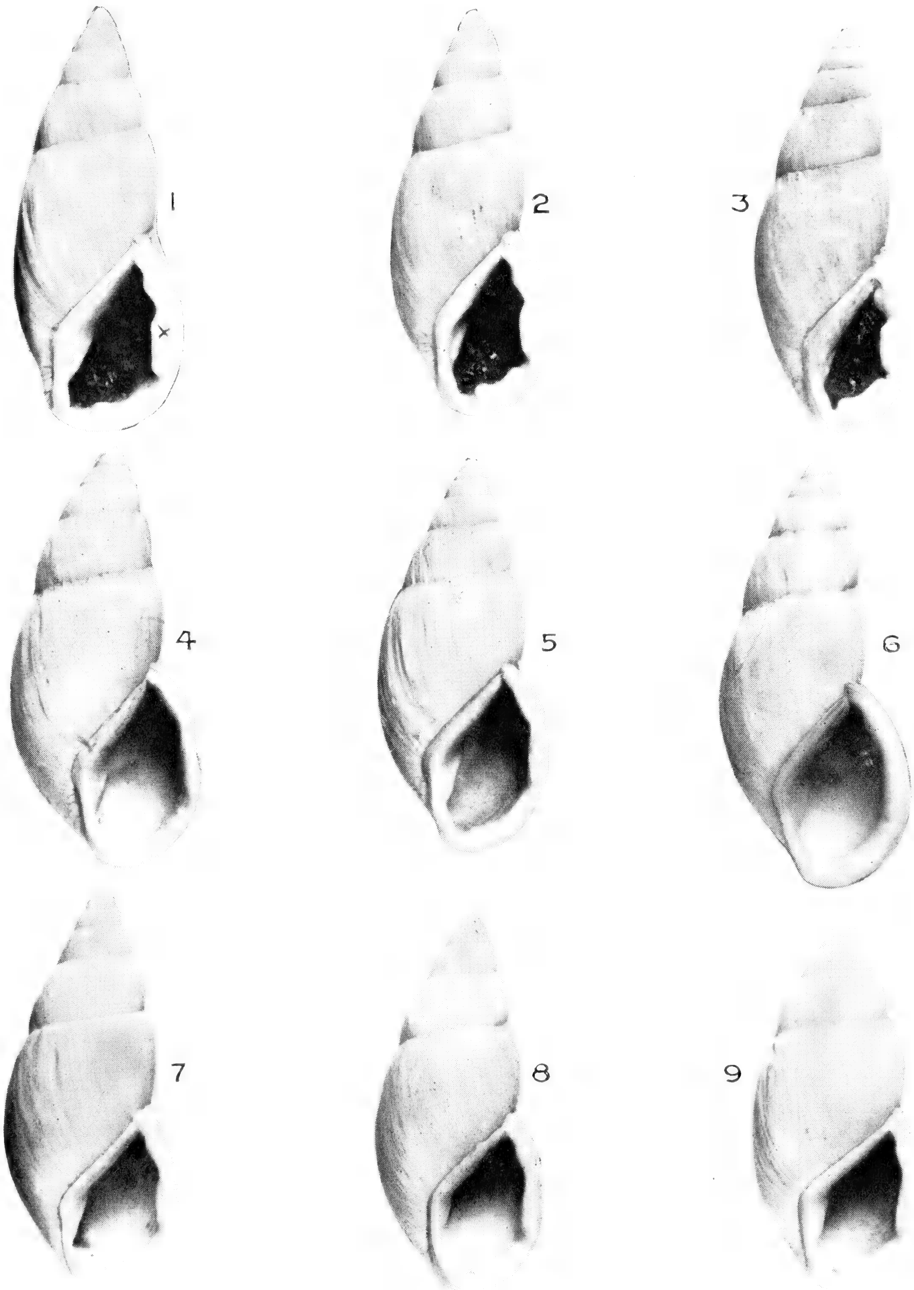
The inferences are that (1) the insular stock on the former "North Cape Block, Island," spread over the tombolo when it was formed, which was probably in post-Pleistocene times. (2) The dunes at the time these snail colonies lived were covered with coastal forest. Although Placostylus can live in semi-arid conditions the dunes contain the remains of *Rhytida dunniae* as well as *Placostylus*, indicating that rather moist conditions then prevailed. (3) The time factor, or more likely increasing dryness, evidently prevented *watti* from joining up with the high-country *annectens* at Unuwhao.

There is very little vegetation remaining on the North Cape block, and it is doubtful if this subspecies will long survive the inroads of fires and the trampling by cattle.

The species is named in honour of Mr. A. H. Watt, of Paua, Parengarenga.

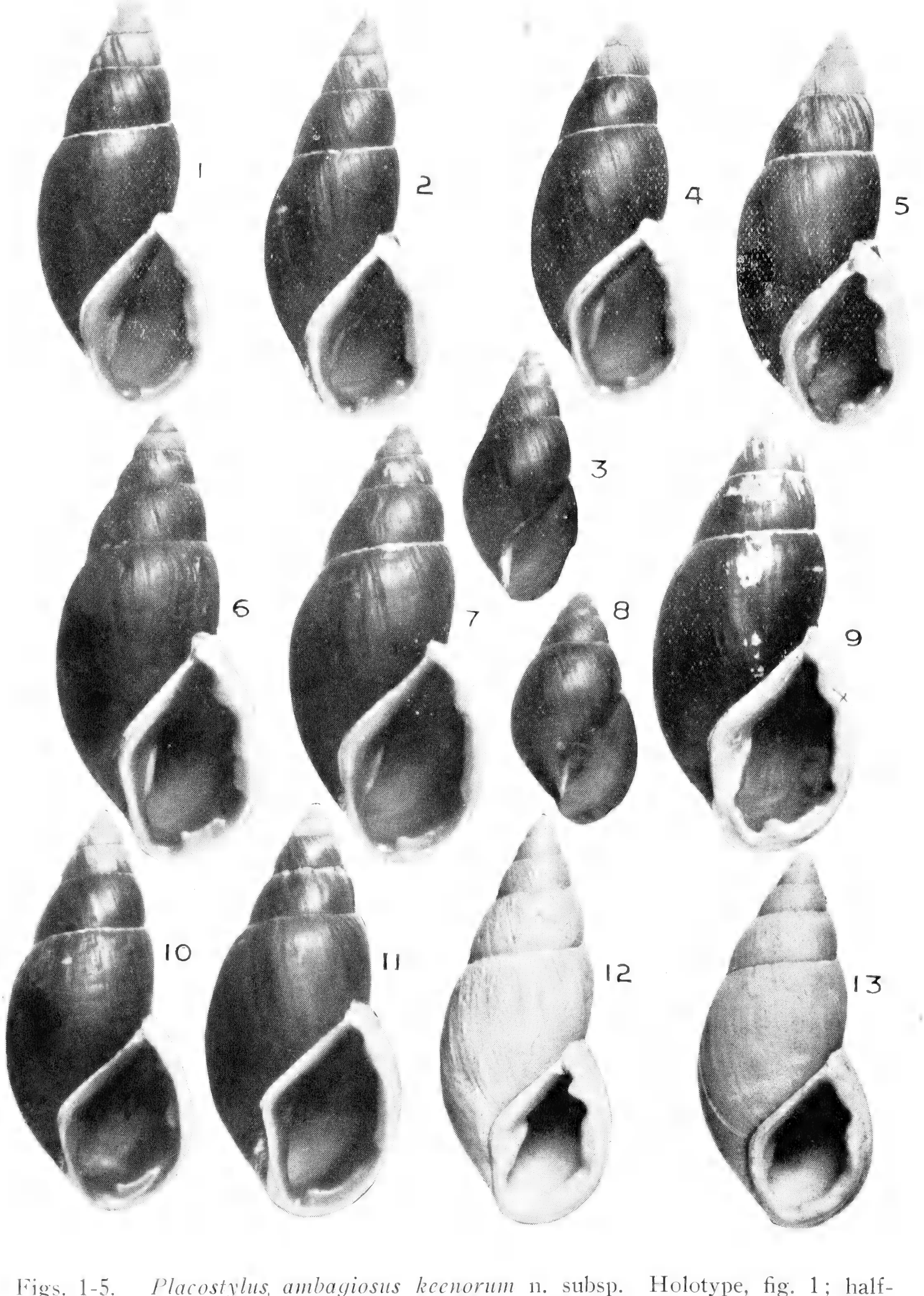



Figs. 1-3. *Placostylus ambagiosus ambagiosus* Suter, 1906.
Gigs. 4-6. *Placostylus ambagiosus hinemoa* n. subsp. Holotype, fig. 4.
Figs. 7-9 *Placostylus ambagiosus worthyi* n. subsp. Holotype fig. 7.
Figs. 10-12. *Placostylus ambagiosus consobrinus* Powell,1938. Holotype, fig. 10.
(All figures reduced to uniform scale)




Figs. 1-3. *Placostylus ambagiosus priscus* Powell, 1938. Holotype, fig. 1.
Figs. 4-6. *Placostylus ambagiosus lesleyae* n. subsp. Holotype, fig. 5.
Figs. 7-9. *Placostylus ambagiosus spiritus* n. subsp. Holotype, fig. 7.

(All figures reduced to uniform scale)




Figs. 1-5. *Placostylus ambagiosus keenorum* n. subsp. Holotype, fig. 1; half-grown example, fig. 3; Maungapiko, west side, figs. 4 and 5.

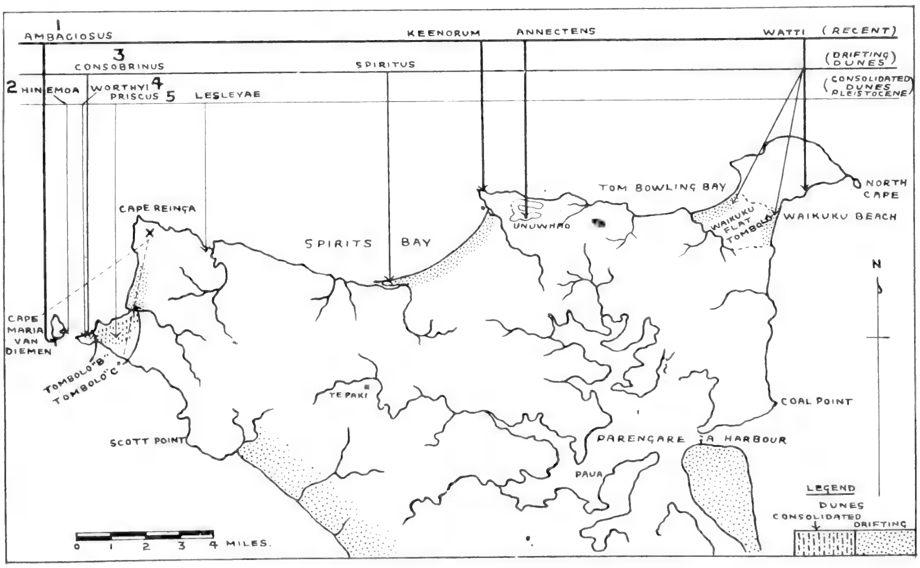
Figs. 6-9. *Placostylus ambagiosus annectens* Powell, 1938. Holotype, fig. 9; half-grown example, fig. 8.

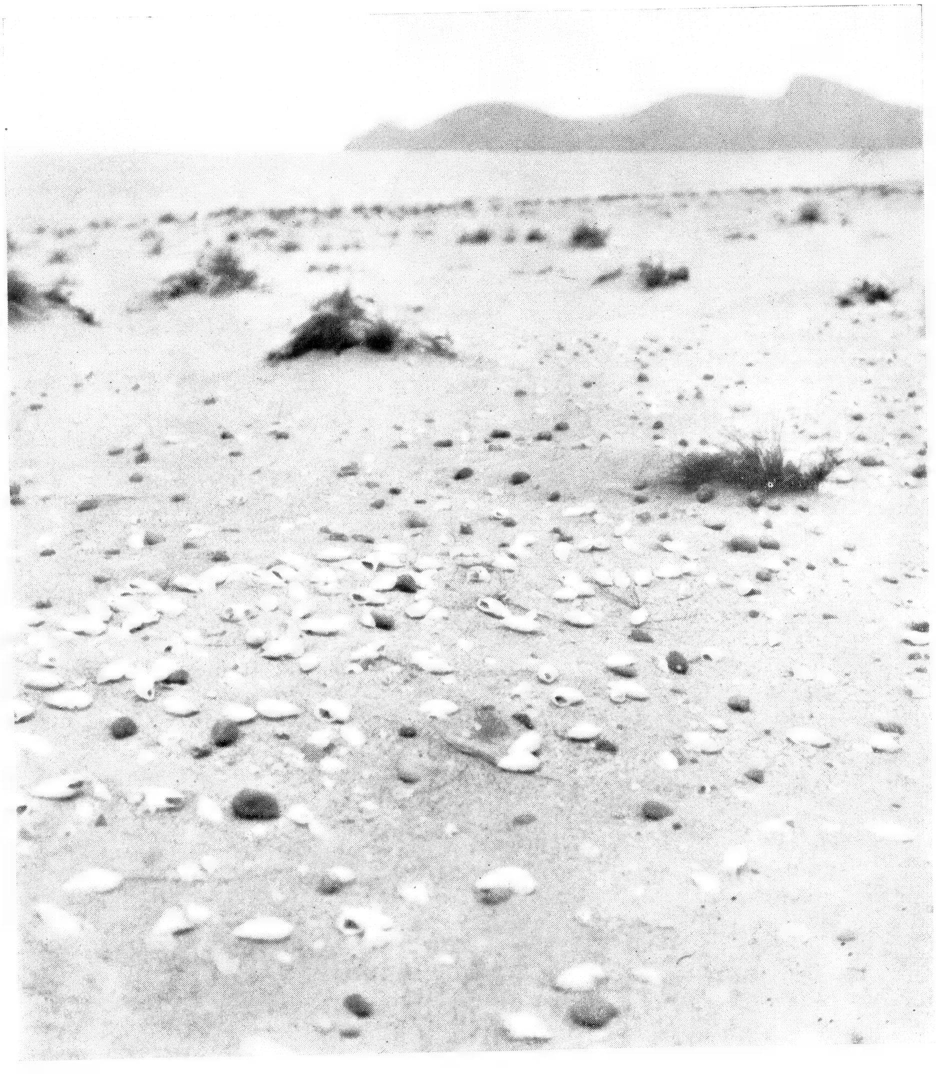
Figs. 10-13. *Placostylus ambagiosus watti* n. subsp. Holotype, fig. 10; Waikuku Beach, fig. 12; Tom Bowling Bay, fig. 13.

(All figures reduced to uniform scale)

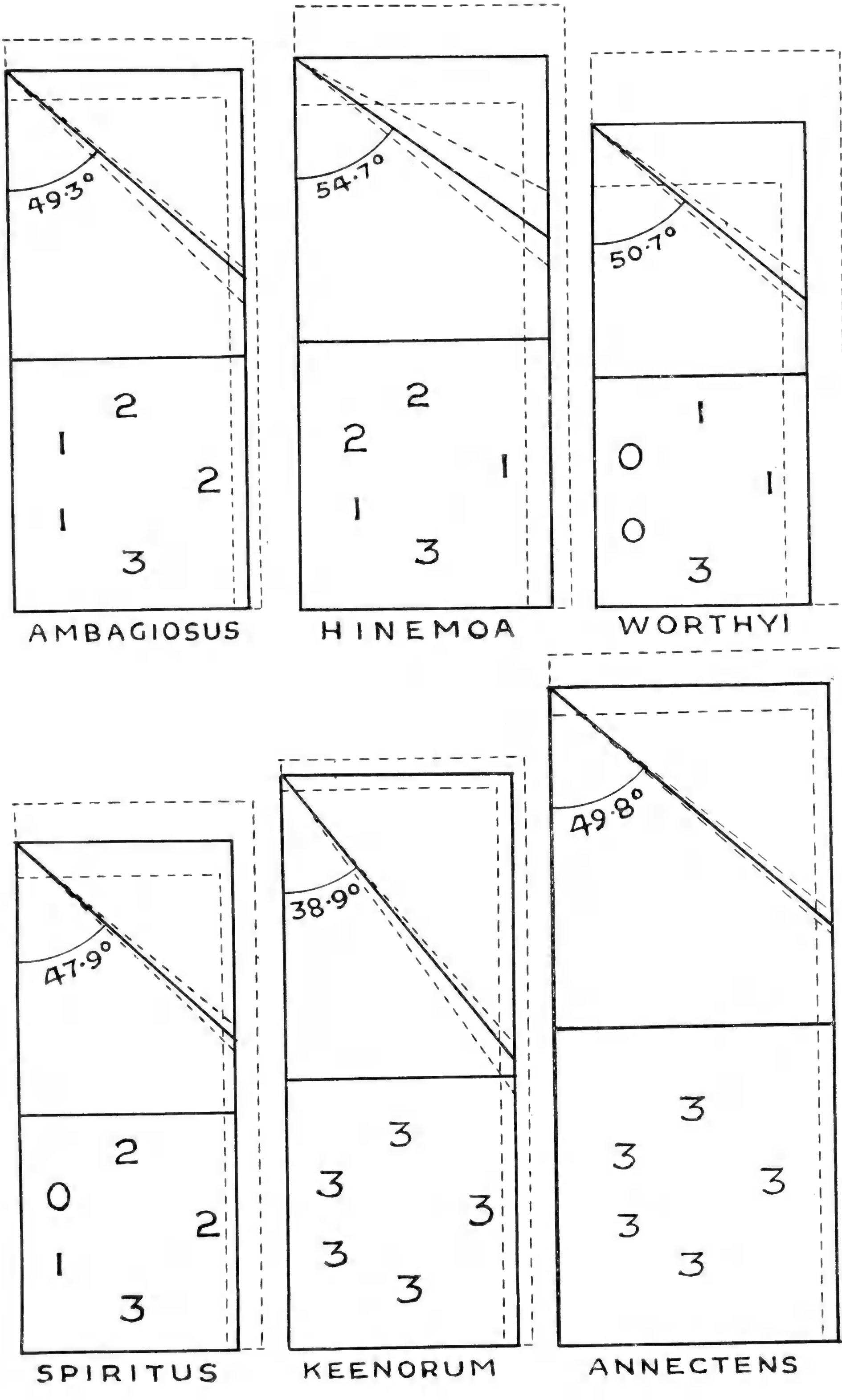

Above: From near Cape Te Reinga looking S.W. (position X on map). A = ¾-mile wide deep waterway separating Cape Maria van Diemen Island from mainland. B = tombolo, site of former waterway. C = tombolo, site of second former waterway. Figures show location of subspecies: 1. *ambagiosus;* 2. *hinemoa;* 3. *consobrinus;* 4. *worthyi;* and 5. *priscus.*

Below: Map of northernmost block (adapted from Bartrum and Turner, 1928).



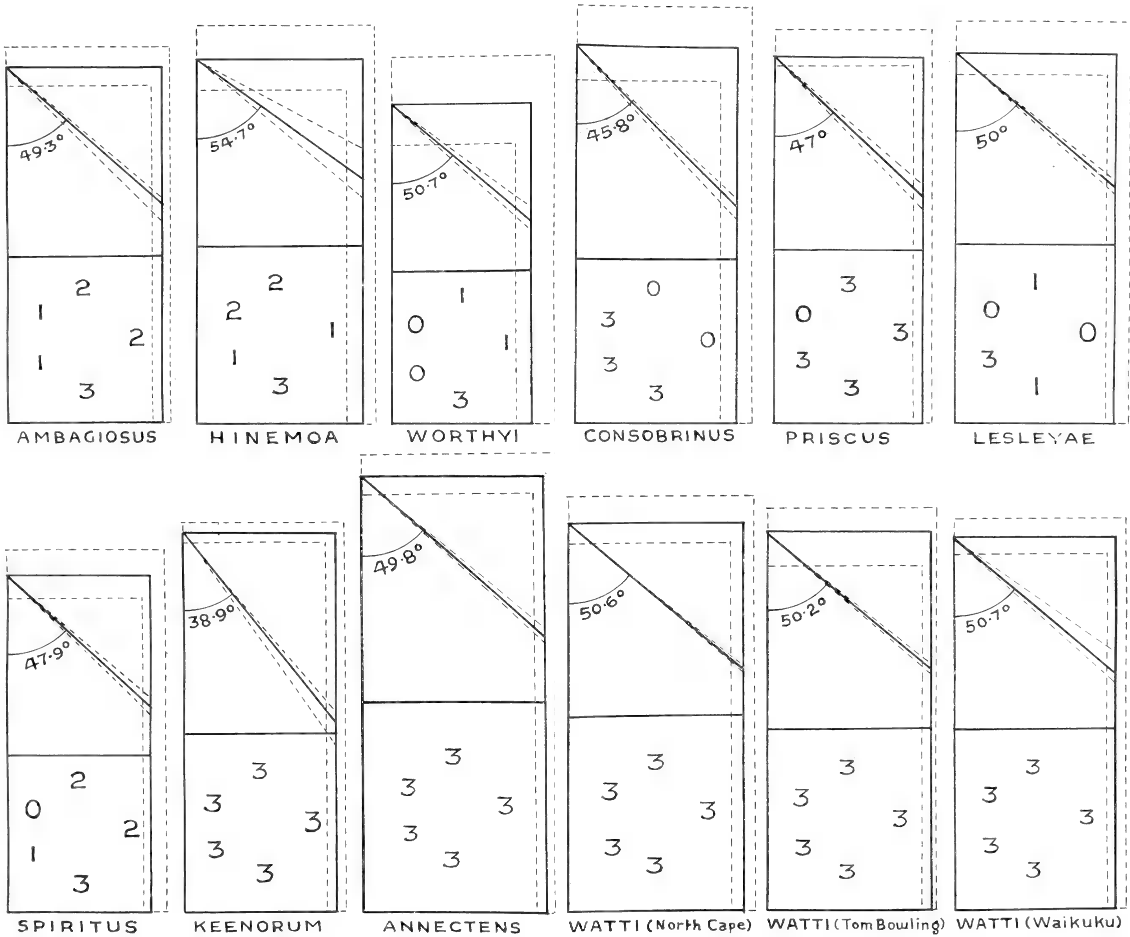


Type locality of *Placostylus ambagiosus spiritus* n. subsp. As the fossils occur in loose dunes two to three miles east of Pandora, Spirits Bay. Former stratification has been telescoped by the action of wind so that the fossil snails and the stones associated with the later period of Maori occupation are brought to a common level.



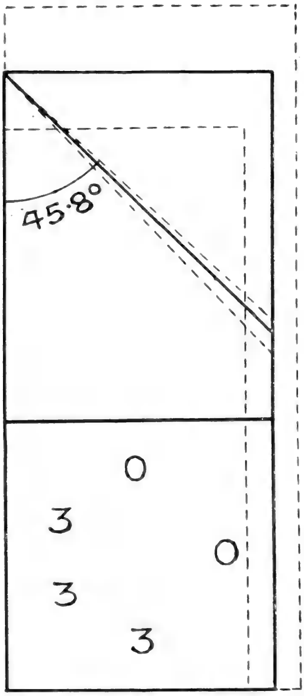

DIAGRAMMATIC KEY.

Representations of shells, all actual size. For description see page 177.

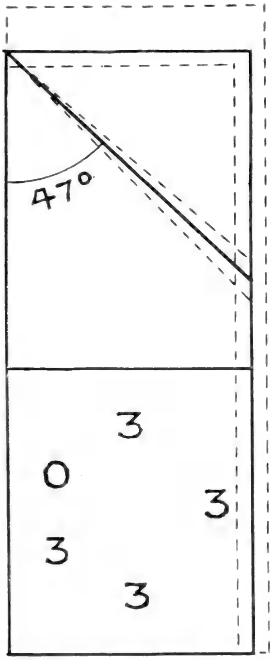



DIAGRAMMATIC KEY.

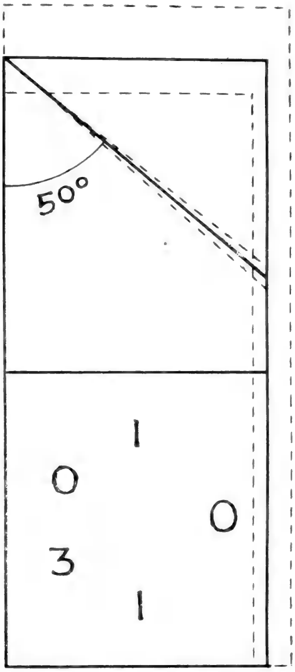
Representations of shells, all actual size. For description see page 177.



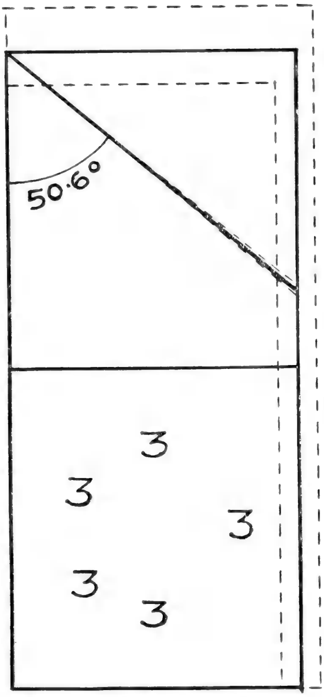

CONSOBRINUS



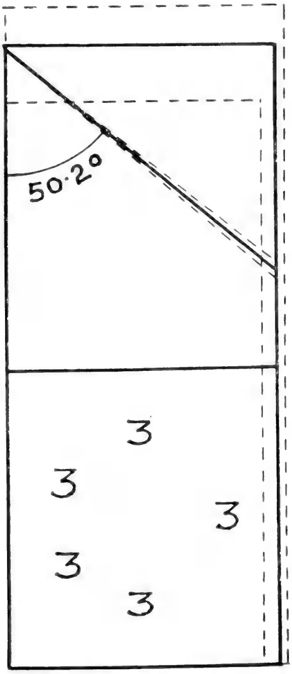

PRISCUS



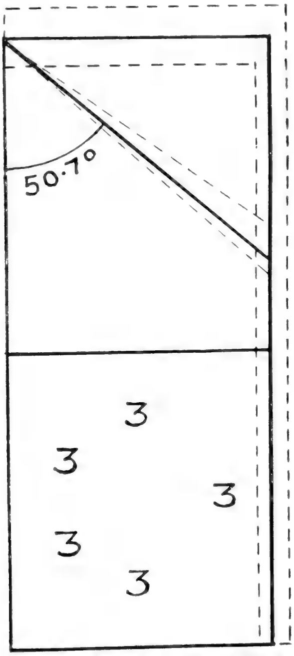

LESLEYAE




WATTI (North Cape)




WATTI (Tom Bowling)




WATTI (Waikuku)

# RECORDS

OF THE

# AUCKLAND INSTITUTE AND MUSEUM

VOL. 3, NOS. 4 & 5

*Published by Order of the Council:*
*Gilbert Archey, Director*

20TH DECEMBER, 1948.

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# CONTENTS

# FOREWORD

The present issue of the "Records" contains accounts of the first stages of regeneration of the flora and fauna of Three Kings Islands following extermination of the goats thereon two years ago.

During the sixty years since their introduction, goats have almost completely changed the nature of the plant covering of Great Island; and, had there not been among the native trees one that withstood their depredations, the island would have suffered the same reduction to bareness and aridity as St. Helena experienced over a century ago.

The few Maori occupants who left Great Island in 1840 may have left animals on the island; we do not know. The only record we have is that goats were introduced in 1889. Fortunately we have two records of the then state of the vegetation, both by Mr. T. F. Cheeseman, Curator of the Auckland Museum.

Occasional visitors since that time have referred to the increasing goat population, but it was not until the Museum's "Will Watch" expedition of 1934 that the extent of the damage being done to the vegetation was realised, while the rapid spread of destruction observed by the "Arbutus" Expedition of 1945 emphasized the parlous plight of the native vegetation.

Mr. Powell, a member of this expedition and at that time Acting-Director of the Museum, reported the conditions, and the urgent need to destroy the goats, to the Government, with the prompt result that the Department of Internal Affairs during the next summer sent its Wild Life section marksmen to the island and within three weeks the goats were exterminated.

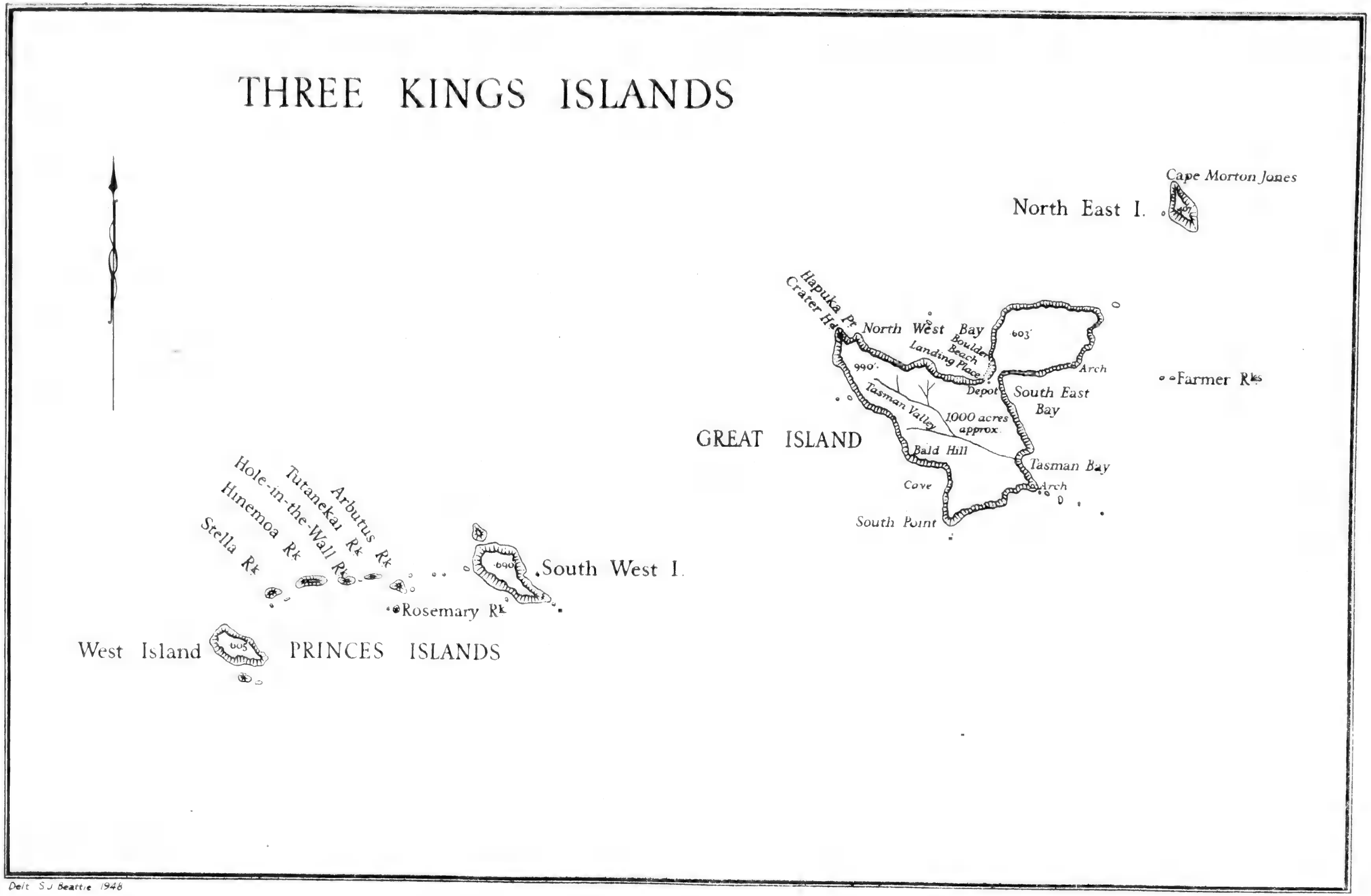
Cheeseman's descriptions of the original vegetation in 1887 and 1889, and the Museum expeditions' records of its conditions in 1934, 1945 and 1946, now provide the basis for studies in natural regeneration on the island. As will be seen from the present reports the change is already most marked, not to say dramatic.

It is hoped to make frequent visits to the islands (the difficult landing conditions will hardly permit of their being regular), whereby the present studies will be followed by detailed descriptions of the progress of regeneration and of the phases through which it may pass.

Only the larger islands of the group are named, and, as it is intended to venture every possible landing to examine the unmodified flora and fauna of the small islands, it becomes necessary to give names by which they can be identified. In offering these new names on the accompanying map, Mr. Powell and Mr. Turbott follow the pleasant tradition of commemorating the adventuring vessels.

It is a pleasure to thank the Royal New Zealand Navy, the Government Departments, and the enterprising and intrepid yachtsmen and launch owners who have made the past visits possible; it is also a pleasure to know that we are assured of their future co-operation and assistance in an interesting and, we venture, a not unimportant investigation.

GILBERT ARCHEY,
Director.




Courtesy Lands and Survey Department

# Chronology of Exploration of the Three Kings Islands

Leading events concerned with the discovery of the Three Kings Islands and the investigation of the flora, fauna, geology and ethnology of the group.

1643—Three Kings Islands discovered by Tasman. Maori inhabitants and cultivations noted, but no landings made. Heeres, J. E. (ed.) 1898, "Abel Janszoon Tasman's Journal, etc." Amsterdam, Frederik Muller.

1772—Marion du Fresne reported that Great Island was still inhabited, and described it as grassy with groves of bushes.
Roth, H. L. (trans.) 1891, Crozet's Voyage to New Zealand, Tasmania, etc., 1771-1772. London, Truslove and Shirley.

1793—D'Entrecasteaux reported signs of occupation including a column of smoke arising from North East Island. Labillardiere, J. J., 1800, Relation du Voyage a la Recherche de La Perouse, etc. Paris, H. J. Jansen.

1835—Rev. W. G. Puckey visited Great Island, to induce the Maoris, who were reputed to be starving, to leave the island, but was unsuccessful.
Puckey, Rev. W. G., 1836—Missionary Register for 1836, p. 473.

1840 (c.)—End of Maori occupation of Great Island.
Cheeseman, T. F., 1888, Trans. N.Z. Inst. 20, pp. 145, 146.

1887—Mr. T. F. Cheeseman, from the N.Z. Govt. Steamer "Stella" made first botanical collection on Great Island.
Cheeseman, T. F., 1888, Trans. N.Z. Inst. 20, pp. 141-150.

1889—Mr. T. F. Cheeseman, from the N.Z. Govt. Steamer "Hinemoa" revisited Great Island and made a landing on South West Island.
Cheeseman, T. F., 1891, Trans. N.Z. Inst. 23, pp. 408-424.

1902—S.S. "Elingamite" wrecked, with considerable loss of life, on the Western King. Some survivors reached Great Island and, according to contemporary press accounts, fired parts of the island.

1907—Provision depot for castaways erected by New Zealand Government on Great Island. Captain J. Bollons of the N.Z. Govt. Steamer "Hinemoa" discovered the large land snail *Placostylus bollonsi* Suter.
Suter, H., 1907, Trans. N.Z. Inst. 40, p. 340.

1908—Three Kings purchased from Maori owners by the Crown.

1911—British Antarctic ("Terra Nova") Expedition dredged bottom material and collected surface samples from around the Three Kings Islands. Reports on most of the invertebrate phyla appeared in *Brit. Ant. ("Terra Nova") Expd.* Zool. vols. 1-8, 1914-1930.

1915—Dr. Th. Mortensen obtained dredgings from the vicinity of the Three Kings Islands while on the N.Z. Govt. Steamer "Hinemoa" in February, 1915. Reports on his material appeared in—Papers from Dr. Th. Mortensen's Pacific Expedition, 1914-16. *Vidensk Medd. fra Dansk naturh. Foren.*

1916—"Preliminary List of Mollusca from Dredgings taken off the Northern coasts of New Zealand." Mestayer, M. K., Trans. N.Z. Inst. 48, pp. 122-128.

1916—"List of Foraminifera dredged from 15′ South of the Big King at 98 fathoms depth."
Mestayer, R. L., Trans. N.Z. Inst. 48, pp. 128-130.
These two reports deal with dredgings obtained by Captain Bollons near the Three Kings.

1928—Lady Alice Fergusson and party, including Mr. W. M. Fraser of Whangarei, camped for three days on Great Island. Mr. Fraser wrote an account dealing with the topography, vegetation, bird life and ethnology of the island.
Fraser, W. M., 1929, N.Z. Journ. Sci. & Tech. 11 (3), pp. 148-156.

1930—Three Kings declared a sanctuary under Animals Protection and Game Act.

1932—R.R.S. "Discovery II" dredged a series of bottom samples at depths between 92 and 260 metres. Mr. A. W. B. Powell, who accompanied the expedition, reported on the mollusca, adding six new genera and 128 new species to the fauna. No landings were made.
Powell, A. W. B., 1937, Discovery Reports, 15, pp. 153-222.

1934—Auckland Museum Expedition to Three Kings Islands in auxiliary ketch "Will Watch." Botanical, zoological and geological collections made. In addition to the papers listed, several press accounts appeared in Auckland, as well as an article by R. A. Falla in the "N.Z. Observer."
Bartrum, J. A., 1936. Notes on the Geology of the Three Kings and other outlying Islands of Northern New Zealand. N.Z. Journ. Sci. & Tech. 18 (6), pp. 520-530.
Falla, R. A. A new *Anthornis* from the Three Kings Islands (this number).
Powell, A. W. B., 1935. Land Mollusca of the Three Kings Islands. *Proc. Malac. Soc.* Lond. 21 (4), pp. 243-248.

1945—H.M.N.Z.S. "Arbutus" landed an Auckland Museum party (Messrs. G. T. S. Baylis, G. A. Buddle, P. C. Bull, A. W. B. Powell and R. Wilson) for one week at Great Island. Collections

and observations of plants, molluscs and birds were made. Reports on the material in this number by Baylis, Buddle, Oliver, Powell and Turbott.

1946—New Zealand Government sent Internal Affairs Wild Life Branch Expedition to exterminate the goats on Great Island. Mr. E. G. Turbott, Auckland Museum, who accompanied the expedition, made insect, bird, plant and ethnographical collections and established quadrats for ecological investigation.
Reports on the material in this number by Archey, Baylis, Forster, Oliver, Powell, Turbott, Salmon and Stephenson.

1947—Major M. E. Johnson and Major G. A. Buddle in 26ft. auxiliary keel yacht "Rosemary" landed during January upon Great Island, North East Island and South West Island. They found abundant signs of former Maori occupation on North East Island and made from there the first natural history collections.
Reports on the material in this number by Buddle, Oliver and Powell.

1948—Major M. E. Johnson, Major G. A. Buddle and Dr. G. T. S. Baylis made landings on Great Island and North East Island in January from the "Rosemary." Further natural history collections were made and are reported upon in this number by Baylis and Powell.

1948—Mr. A. J. Black, of Dunedin, transported a Museum party of four (Messrs. Battey, Buddle, Powell and Turbott) in his motor vessel "Alert." Four hours were spent on Great Island.

# The Outlying Islands of the Three Kings Group

By G. A. BUDDLE.

In January, 1947, an opportunity arose for the writer to visit the Three Kings group with the particular object of examining the outlying islands about which so little was known and with a view to obtaining information regarding possible landings, etc., which might pave the way for a more elaborate expedition at a later date, should any discoveries made warrant it.

Leaving Auckland on 27th December, 1946, in the 26ft. keel yacht Rosemary (equipped with an auxiliary engine), after a stop of several days at Mangonui awaiting suitable weather conditions, the Three Kings were reached early on the morning of 3rd January, 1947. As weather conditions appeared favourable, an immediate approach to South West Island was made: a close circuit of the island and examination of possible landing places resulted in the selection of a spot near or identical with the one described by Cheeseman. This point is about 100 yards from the extreme S.E. point of the island and faces Great Island (Pl. 26, fig. 1): the point of the island diverts the prevailing westerly swell; but, being in the passage separating the two islands, it was found that except at or near slack water the tide ran so strongly that it was impossible to manoeuvre the 7ft. dinghy in which the landings were made, more particularly as there is at this point a broad belt of bull kelp to add to the difficulties created by the current and the ocean surge, which ranged from 7 to 14 feet during the whole of our stay in the group. Waiting till slack water, and carefully timing the approach to the landing to coincide with the top of the surge, the dinghy was backed in to within jumping distance of the rock face (which descends vertically into 20-30 fathoms) and one at a time Major Magnus Johnson (the owner of the yacht) and the writer were landed successfully; while the dinghy was rowed back to the yacht, which was anchored in 40 fathoms about $\frac{1}{4}$ mile off shore. Once ashore, the ascent of the cliffs was not difficult.

In December, 1947, another expedition was organized to continue the exploration of these outlying islands. A landing by Major Johnson and the writer was made on the North East Island on 31st December, 1947. Photographs were taken and living specimens were collected of two new species of *Rhytida,* a land snail, of which only dead shells were found during the first visit. Unfortunately, bad weather necessitated a return to the mainland and further exploration had to be abandoned.

## SOUTH WEST ISLAND.

South West Island is roughly oval in shape, the long axis running in a N.W.-S.E. direction, and is about $\frac{1}{2}$ a mile in length. The area of the island is about 70 acres: it is bounded by cliffs varying in height from

about 50ft. near the landing to 400-500ft. at the N.W. point. Ascending the cliffs above the landing and turning to the N.W., the ground rises in a steady slope to the summit (690ft.), where it drops off abruptly in sheer cliffs: to the north and east are very steep slopes, cliffs and ledges carrying here and there a little sparse vegetation, and appearing for the most part quite inaccessible. Turning westward from the landing and forcing a way through very dense windswept scrub consisting chiefly of flax (*Phormium* sp.), ngaio (*Myoporum laetum*) and *Coprosma macrocapa*, one comes to the foot of a broad, open gully which heads out at the top of the cliffs about the middle of the westrn face of the island; this gully is clothed with a luxuriant growth of coastal forest trees, including pohutukawa (*Metrosideros excelsa*), kawa kawa (*Macropiper excelsum* var. *major*), wharangi (*Melicope ternata*), puka (*Meryta sinclairii*), and *Coprosma macrocarpa*. At the head of this gully a dense growth of flax commences which covers the whole of the very steep western face of the island, except where, here and there, more or less level ledges or plateaux carry a growth of puka, *Coprosma macrocarpa,* kawa kawa and other species.

To the north as one ascends to the summit of the island, the grade eases off to a gentle sloping plateau which is the site of the largest grove of puka on the island, several acres in extent: this park-like area is almost entirely puka, there being little or no undergrowth except round the fringe of the area. The trees range up to 2ft. 6in. in diameter and up to 30ft. in height. The forest floor is carpeted with dead leaves to a depth of 8-12 inches and the canopy overhead shuts out all trace of the sky. Seedlings and small trees were noticed round the fringe of the area, but none were seen through the greater part of the grove. Plate 27 (fig. 2) shows typical vegetation round the fringe of the puka area.

Continuing the ascent to the summit, the puka grove gradually gives place to a tangled growth of windswept, stunted shrubs and flax, through which a track had to be cut, which brought us out to the top of the ridge, which narrows at this point almost to a knife edge, with cliffs to the west and very steep slopes to the east, broadening out at the summit to a small grassy plateau with patches of grass and tussock (Pl. 26, fig. 3). *Hebe insularis* was noted to be particularly plentiful in this area.

**Geology**

The bulk of the island appeared to be composed of greywacke similar to that of Great Island: the cliffs at the summit and facing the N.W. end, however, appeared to be of a different type, resembling the columnar structure of the Princes Islands, the origin of which was at that time unknown. A specimen of rock from the summit was submitted to Professor J. A. Bartrum for examination, and I am indebted to him for its identification as an andestic lava. Professor Bartrum has kindly written a paper, which appears in this volume, giving a full description of this rock, together with other specimens obtained later from the Princes Islands. Unfortunately, in the stress of embarking under difficulties no specimens were obtained from the southern part of the island.

## Botany

In addition to plants identified in the field, the following specimens were obtained, for the identification of which I am indebted to Dr. G. T. S. Baylis.

*Coprosma macrocarpa* Cheesem.
*Cyperus ustulatus* A. Rich.
*Davallia tasmani* Cheesem.
*Hebe insularis* (Cheesem.) Ckn. & Allan.
*Hymenanthera novaezealandiae* Hemsl.
*Macropiper excelsum* var. *major* Cheesem.
*Paratrophis smithii* Cheesem.
*Wahlenbergia gracilis* Schrad.

These specimens and their relationship to the plants of the other islands are discussed fully by Dr. Oliver and Dr. Baylis in their papers following.

## Ornithology

Cheeseman, 1891, p. 414) reports having seen the following land birds: Bell bird, fantail, warbler, silvereye, morepork and harrier. We did not on this occasion see fantail, warbler, silvereye or morepork, but the bell bird was fairly plentiful and, as far as could be observed, identical with specimens from Great Island. Several species not recorded by Cheeseman were observed: the spotless crake (*Porzana tabuensis*) was fairly plentiful, and one nest was found. Several kingfishers (*Halcyon sanctus*) were seen, and a good number of red-fronted parakeets (*Cyanoramphus novaezelandiae*); also a pair of pipits (*Anthus novaeseelandiae*) on the summit. Several flocks of starlings (*Sturnus vulgaris*) were present and also many blackbirds (*Turdus merula*), which probably are strong competitors of the spotless crake for insect food on the forest floor: the blackbird appeared to be thriving on all the islands visited. Several nests with young were found. Near the summit a small brown bird, in colouring resembling a cock sparrow, was twice seen. It had the general appearance and flight of a finch, but could not be identified. On the whole, land birds are not plentiful; possibly due to lack of water, of which we saw no sign on the island.

Of the sea birds, Cheeseman refers to many petrel burrows which he was unable to examine, and refers only to a specimen of *Puffinus assimilis*: a number of burrows were examined by us, many containing young of the fluttering shearwater (*P. gavia*) and a few young of the diving petrel (*Pelecanoides urinatrix*). There were also a number of larger burrows, in one of which was found a fully fledged grey-faced petrel (*Pterodroma macroptera*). All others examined were unoccupied, but from the appearance of feathers in the vicinity they all appeared to be burrows of the last species. As far as our examination went, the petrel population of the island appeared small compared with similar islands, such as Poor Knights and Hen and Chickens: the top of the island is almost devoid of burrows, particularly the puka areas, which seemed eminently suitable for burrows, but possibly the very dense canopy overhead prevented convenient landings at night. A careful watch was kept for signs of Buller's shearwater (*Puffinus bulleri*),

which Dr. Falla (1934, p. 250) had suggested as probably nesting in this group, but no signs were seen and very few of this species were seen at sea: unfortunately, time did not permit of an examination of the steep flax-covered slopes of the western face, which appeared likely areas for the nesting of petrels.

On the lower slopes at the S.E. end of the island, below the vegetation, was a large colony of red-billed gulls (*Larus novaehollandiae*) several thousand strong. At this date (3/1/47) less than 1% were hatched, and many eggs were freshly laid. From the summit of the island looking down towards this colony it was noticed that flocks of these gulls were excitedly wheeling and circling, with much screaming and quarrelling, close over the top of the puka groves: on our way back to the landing, the cause of this excitement was looked for, and it appeared that the gulls were feeding on the puka fruit. The upper surface of the canopy was a smooth carpet with bunches of fruit protruding through here and there; these were being eagerly devoured by the gulls.

Adjoining the gull colony and slightly higher up where the scrub began, the open cliff edge provided nesting places for a colony of gannets (*Morus serrator*): 180 nests were counted in this colony and about 40 more in two smaller colonies on the west side of the island: in most cases the eggs were laid on the bare ground and such nests as were observed were of much flimsier construction than usual, probably owing to a lack of suitable nesting material. Not more than about half a dozen chicks were seen and no young of the year were observed at sea, though there were quite a number of dead young about the gannetry. It was noticed that this colony was apparently on the increase, as at the upper end the nests were encroaching on the scrub, which was gradually being killed; several of the nests were as much as 20 feet inside the growing scrub, mostly kawa kawa.

**Mollusca**

A close search was made for *Placostylus bollonsi*, several colonies of which had been found on Great Island, but no signs even of dead shells were found. On the fringe of the puka grove well up on the west side of the island, the shell of a very large *Rhytida* was found: this has proved to be a new species which is being described and named by Mr. A. W. B. Powell.

**Insects, etc.**

A number of beetles, wood lice and other invertebrates was collected, although members of these groups did not appear common.

**Maori occupation**

No signs of previous Maori occupation were observed: however, I have been told by Mr. H. King, of Russell, that many years ago an old Maori had told him a story to the effect that one of his ancestors, having quarrelled with the natives of Great Island, where he was living, removed with his family to South West Island, where they remained for many years.

**Goats**

According to the records of the Marine Department a pair of goats was liberated in 1889, when Cheeseman visited the island. Fortunately, they did not survive; we saw no goats nor any sign that they had ever been there.

## NORTH EAST ISLAND.

As far as I am aware no previous landing has been made on the North East Island, and the only published reference to it appears to be by Cheeseman (1891, p. 419), who states: "While I was engaged in the examination of the Great King, Captain Fairchild paid a visit in the 'Hinemoa' to the East King to ascertain whether a landing could be effected. It proved to be exceedingly rocky and precipitous on all sides; and although with care it would have been possible to land at the foot of the cliffs, it appeared to be quite impossible to reach the top of the island. Acting, therefore, on his advice, I made no attempt to land. It is about the same size as the Western King, but is rounder in outline and a little higher. The whole of the top is covered with light bush, mainly composed of the puka, which appears to be even more plentiful than on the Western King. Cabbage trees (*Cordyline* sp.) and pohutukawa were also seen, but the steamer could not be taken sufficiently close inshore to identify any other species."

On the morning of 4th January, the weather being favourable, a light north-westerly breeze and moderate swell, a close circuit of the island was made in the yacht and several places were noted where a foothold at the base of the cliffs could be obtained. but in most cases there appeared to be an overhanging ledge of rock or vertical face which would completely prevent an ascent to the top. However, at the southern tip, which juts out far enough to slightly divert the prevailing westerly swell, we noticed a creviced face and small sloping ledges which looked promising, and, taking advantage of slack water, Major Johnson and I landed one at a time without great difficulty, and found the climb to the top not as difficult as it appeared from the sea: we took rope to assist in climbing, but fortunately found it was not required. (Plate 27, fig. 3.)

The island is about 500 yards in length by 250 yards in breadth, and the height 407 feet; it is roughly oval in shape, with steep cliffs all round, varying from 100-300 feet in height. Climbing up from the landing, the slope of the bare rocky face of the cliff eased off at about 200 feet and the first signs of vegetation appeared in the form of mosses, lichens and sedges, then creeping plants, such as *Disphyma australe*, native cucumber (*Sicyos angulata*) and panahi (*Ipomoea palmata*), and then wind-swept, stunted ngaio, *Coprosma macrocarpa* and wharangi, giving place, as we reached the plateau, to a luxuriant growth of pohutukawa, puka, kanuka (*Leptospermum ericoides*), *Coprosma macrocarpa,* and kawa kawa. The greater part of the top plateau is occupied by a magnificent grove of puka, 3-4 acres in extent, open and park-like, there being no undergrowth of any description except round the fringes: on the eastern and southern side the puka forest extends to the cliff edge, where vegetation ceases. On the north and west it ceases slightly

below the ridge which forms the backbone of the island, and here the ground drops off in a series of steps, terraces and broken slides well covered with vegetation, including pohutukawa and large kanuka, until the sheer cliffs dropping off into deep water are reached.

This island is not so dry and arid as South West Island, and the puka especially seemed to be more luxuriant in growth; towards the eastern end several specimens 3 feet in diameter were noted, close to a large patch of bracken (*Pteridium esculentum*). A number of specimens of the plants were obtained, but, unfortunately, many were lost in embarking. I am indebted to Dr. G. Baylis for the identification of specimens of the following:

*Carex forsteri* Wahl.
*Davallia tasmani* Cheesem.
*Ipomoea palmata* Forsk.
*Melicope ternata* Forst.
*Meryta sinclairii* Seem.
*Oplismenus undulatifolius* Beau v.
*Paratrophis smithii* Cheesem.
*Pittosporum fairchildii* Cheesem.
*Pyrrosia serpens* (Forst. f.) Ching.
*Rhagodia nutans* R. Br.

**Bird Life**

Very few birds were seen and no specimens obtained. Half a dozen bell birds (*Anthornis melanura*) and a pair of red-fronted parakeets (*Cyamoramphus novaezelandiae*) were the only indigenous bush birds. There were very few petrel burrows, apparently all unoccupied, but probably the bulk of the petrel population, which cannot be large, is situated on the north and west faces, which were not examined. Several small flocks of starlings, and the ubiquitous blackbird, were also present. No gulls or gannets nest on this island. A small brown bird was seen by Major Johnson, apparently similar to the unidentified one seen on South West Island.

**Mollusca**

*Placostylus bollonsi* is plentiful and not congregated in small colonies as on Great King, but appeared to be fairly evenly distributed over all parts of the island examined. Sixteen live specimens and a number of eggs were obtained, and also several specimens of a previously unknown species of *Rhytida*; these and the *Placostylus* are dealt with by Mr. A. W. B. Powell in his paper on the Mollusca of the group.

**Maori occupation**

The greater part of the puka grove, perhaps 3 or 4 acres, has been cleared of stones and walled and terraced by Maoris: in some cases the walls are still standing, but mostly are now represented merely by piles and lines of stones, through which pukas up to 3 feet in diameter and 30 feet in height are now growing: these have the appearance of having grown since the date of the last Maori occupation. In this connection, the following quotation from the narrative of d'Entrecasteaux (Labillardiere: Voyage in search of La Perouse) may throw some light. "At daybreak on the 13th (March, 1793) we made the islands called

the Three Kings. About 8 o'clock, being in longitude 169° 56′ East we set the middle island of the group north distant one league and ascertained its latitude to be 34° 20′ south. We saw three principal rocks of a moderate height, nearly in the same parallel at no great distance from one another, and surrounded by other rocks that were much smaller. Notwithstanding the fog that had just come on, we distinguished some more rocks towards the south, making a part of the same cluster. They were very bare and we did not suppose them to be inhabited, but a large column of smoke arising from the easternmost islet informed us that there were savages on it. No doubt they chose this place of residence because it afforded them an opportunity of procuring fish with ease from among the shoals. About three quarters after ten we made the land of New Zealand, which we approached by steering easterly under favour of a light breeze from the west north west."

Owing to the fact that North East Island has hitherto been considered totally inaccessible, this reference may be interpreted as referring to Great Island, but for the following reasons I consider it probably refers to North East Island:—

1. D'Entrecasteaux refers to the *eastermost* islet, and sailing on an easterly course a league to the south of the group he could hardly fail to see it if Great Island were visible, in spite of his mention of fog, as it is 400ft. in height and would be nearer to him than Great Island.

2. He refers to an *islet* and not an island.

3. It is actually reasonably accessible in fine weather.

4. His reference to shoals of fish, which in my experience, at this season of the year, are usually congregated in this area, which generally speaking is the lee or sheltered side of the group.

If my surmise is correct, this would indicate that the island was inhabited at least as late as 1793, and it is reasonable to assume that they were inhabited, at least periodically, until the final evacuation of the Great King some time after 1835 (Cheeseman, 1888, p. 145).

## PRINCES ISLANDS.

The Princes Islands comprise a group of rocky islets set in a crescent between West and South West Islands. There are five islets ranging from 100-200 yards in length, separated by narrow but deep passages, together with a large number of smaller outlying rocks. The average height is about 100 feet, and steep cliffs descend into 20-30 fathoms of water on all sides. On one or two of the larger islets there is a scanty vegetation of *Disphyma australe,* flax, sedge and a few very stunted taupata (*Coprosma repens*) ; the remainder are barren, wave-swept rocks without vegetation or soil. (Plate 27, fig. 1.)

A landing was made on one of these islets (the third from the western end of the chain), which is pierced by a tunnel running right through the island. Specimens of plants comprising the following species were obtained and have been identified by Dr. Baylis:

*Coprosma repens* Richard.

*Disphyma australe* (A. Cunn.) Black.

*Lepidium oleraceum* var. *frondosum* Kirk.

*Rhagodia nutans* R. Br.

The top plateau of this island is occupied by a nesting colony of gannets (*Morus serrator*) estimated at about 500 birds; intermingling with these and extending down the slopes were numbers of red-billed gulls (*Larus novaehollandiae*) (outnumbering the gannets by 4 to 1). Similar colonies existed on three other of the islets. No other birds were seen: there is no ground in which petrels could burrow. At the time of our visit several young gannets had hatched out, and as we walked through the colony some of them vomited the fish with which they had recently been fed, and from under the rocks appeared numbers of large skinks (*Lygosoma*) which gorged themselves on the partly digested fish.

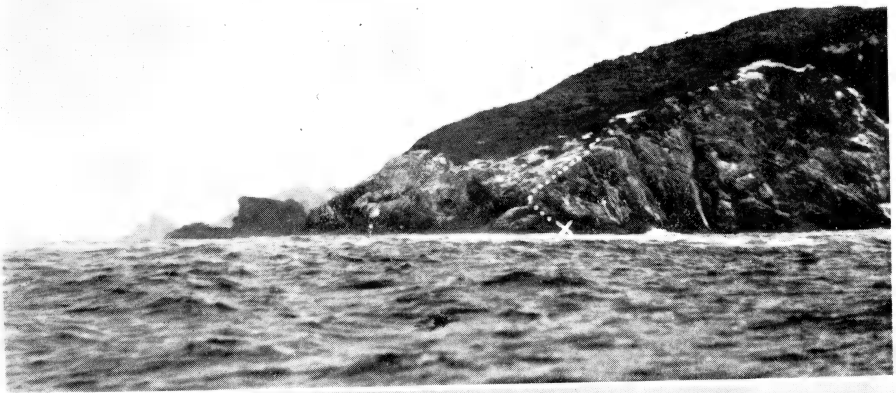
**Geology**

This group of islets has never before been examined, but from observation from the sea the columnar structure of the rock indicated a probable volcanic origin, different from that of the larger islands of the group, which are composed mainly of greywacke. Specimens of rock were obtained from two parts of the group, and I am indebted to Professor J. A. Bartrum, of Auckland University College, for their identification as andesitic lava: he is contributing a paper describing this rock in detail and its relationship to the remainder of the group and the northern coast of the mainland. Owing to adverse weather conditions, landing on any other of the islets was not possible, but the geological formation appeared to be the same throughout and extended to the N.W. end of the South West Island, where specimens of similar but somewhat more weathered rock were obtained.

## WEST ISLAND.

West Island is roughly triangular in shape with the base facing north west; it rises steadily from low cliffs at the south east to the summit (605ft.) near the northern face, very much like a smaller edition of South West Island: it is if anything more rugged and precipitous than the latter. The area is probably about 40-50 acres.

As far as is known, no landing has yet been made on this island, and owing to unfavourable weather no attempt was made on this occasion, but a close examination of the shore line was made with a view to locating a possible landing place for future operations. The most likely spot is situated near the southern point of the island and facing the south west: no great difficulty would be experienced in climbing to the



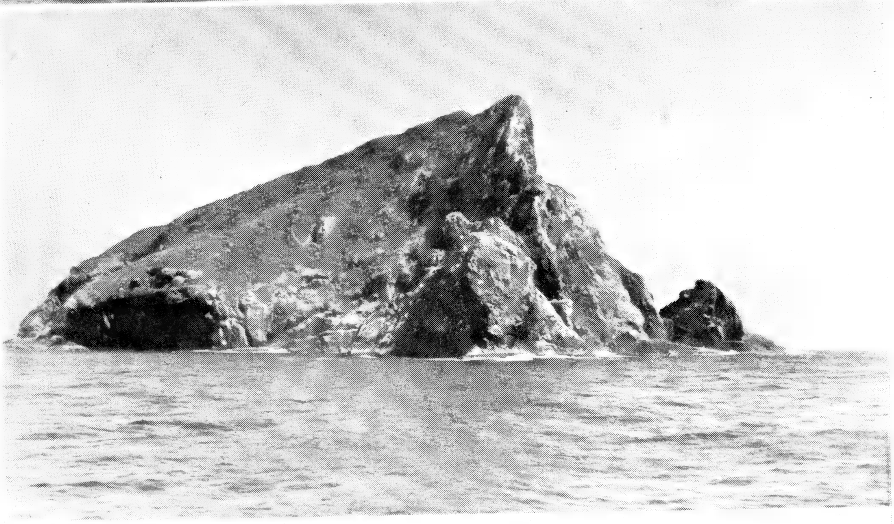


Fig. 1. The landing place on South West Island (marked X). Red-billed gulls (*Larus novachollandiae*) nesting on the lower slopes and gannets (*Morus serrator*) nesting along the cliff edge.

Fig. 2. South West Island, seen from the North.

Fig. 3. The summit of South West Island (690ft.). The pyramid marks the division between the greywacke, of which the bulk of the island is composed, and the andesitic lava, forming the northern cliffs.

top of the island if a landing were made at this point, but this could only be done in light easterly weather. Another point where it seemed possible to scale the cliffs is situated directly opposite, on the N.E. face opposite to Princes Islands, but the tide rip in this passage is one of the worst in the whole group and would render the operation exceedingly hazardous.

The island is for the most part covered with bush of very similar size and growth to that on South West Island. We could clearly identify quite large areas of puka, pohutukawa, kanuka and what appeared to be either *Coprosma macrocarpa* or *Melicope ternata*. Cheeseman's description of the vegetation appears to be somewhat inaccurate, probably due to the distance from which he observed it: he says (Transactions of N.Z. Institute, 23, p. 409) : "Rounding the island at a distance of about half a mile, the vegetation was evidently scanty. Here and there some dark green patches showed on the cliffs, probably composed of trailing masses of ice plant and *Coprosma repens,* and with the glass some stunted flax and toetoe grass could be seen growing on the top, as also a few shrubby plants which it was impossible to identify, but on the whole the island presented a barren appearance and was little more than a bare rock."

In 1902 the "Elingamite" was wrecked on West Island; it is believed that one or two survivors were thrown up on the rocks and afterwards taken off, and one or two fishermen claim to have landed on the rocks, but so far as is known no one has ever explored the island. After the "Elingamite" wreck pressure was brought to bear on the Government by shipping interests to erect a lighthouse on the island, and an examination was made to investigate the possibility of doing so. I am indebted to Mr. F. W. Furkert, late Chief Engineer of the Public Works Department, for the following information: the Marine Department reported to the Auckland Chamber of Commerce that "The Western Islet is an extremely precipitous rock of such a nature that it would be hazardous and dangerous to land on it, and after landing it would need an experienced mountaineer to scale it. To erect a light on this island would be a difficult and tedious task, and to locate a staff there to attend to it would practically make them prisoners. An automatic light on this island would also require enormous difficulties to be surmounted in addition to the risk of this giving out through exhaustion of gas by inability to land fresh cylinders, which would also be a source of trouble."

It was the opinion of Captain Bollons and his officers that it might be possible to land (a jump ashore landing) on an average of one day a month. Owing to the great difficulties and expense entailed, the proposal was dropped and instead a survey was made and a scheme approved for two lighthouses on Great Island; two being necessary owing to the fact that one or the other would be obscured by West Island in certain positions from a vessel approaching from the west; however, before work was actually commenced it was decided to rely on the Radio Station at Cape Maria, and the project was dropped.

In closing this account I would like to express my thanks to Major Magnus Johnson, whose local knowledge, derived from two previous visits to the group, proved invaluable: his good judgment and skilled handling of small boats (ably assisted by his crew, Messrs. E. Beaver and M. Green) enabled three successful landings to be made under very difficult conditions.

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Fig. 1. Princes Islands and West Island (in the background) from the summit of South West Island.

Fig. 2. A typical scene on South West Island, showing the vegetation on the fringe of the puka forest.

Fig 3. The southern point of North East Island, showing the landing place (marked X) and route to the top of the island, where the commencement of the puka grove can be seen on the right.

# Report on Rocks collected by Mr. G. A. Buddle from Islands of the Three Kings Group.

By J. A. BARTRUM, Auckland University College.

On visiting Three Kings Islands some years ago, the present writer (Bartrum, 1936a) was able to land only on Great Island and saw others of the group merely from the sea. He surmised that South West Island was composed of greywacke and several of the Princes Rocks of lava, for they display prominent vertical columnar jointing. His surmise about South West Island proves to be in part if not wholly incorrect, for a rock collected by Mr. Buddle from the summit of the island is igneous and this gentleman has informed the writer that, seen from the sea, there appears to be columnar jointing on part of the steep cliff that descends to the sea from this summit, although the main mass of the island resembles the greywacke of Great Island. The igneous rock collected, however, is indistinguishable from greywacke in hand specimen but for very rare phenocrysts of feldspar about 2 mm. in length.

Thin sections were made of the solitary specimen collected from South West Island and two from several rocks macroscopically similar one to another obtained from Princes Rocks. All prove to be quartz andesites of fairly closely similar nature.

In thin section all the rocks show a good deal of weathering of their feldspar and chloritisation of the original ferromagnesian mineral, which is seen in two of the rocks to be diopsidic augite. The specimens from Princes Rocks are very similar in thin section except that the proportion of identifiable quartz is only about 3% in the one and about 10% in the other. Augite and/or chlorite constitute 10% to 15% and magnetite in small euhedral crystals about 2%, while minute needles of apatite may be fairly numerous and small grains of sphene are plentiful in the rock with the greater amount of quartz, which, however, has no surviving augite. Essentially these rocks consist of approximately 70% of feldspar as unoriented laths of plagioclase (andesine—$An_{40}$) about 0.1 mm. in length with rare phenocrysts of the same mineral usually well under 1 mm. in maximum dimension. In one thin section, augite that has avoided complete chloritisation is locally abundant in small irregular crystals which occasionally show ophitic relations to the laths of feldspar. In the other section, grains of chlorite are enclosed micropoikilitically in feldspar that is between the general laths of this latter mineral.

The rock from South West Island probably represents the same lava as gave rise to the more acidic of the flows of Princes Rocks, but has cooled more rapidly, so that its texture is different. It has about 75% of plagioclase (andesine about $An_{40}$) and about 15% of quartz in relatively large obvious grains. There are a few unchloritised crystals of augite, but even if all the chloritic mineral that is present is derived from this last mineral, the proportion of original augite cannot have

greatly exceeded 5%. Although there are a few small phenocrysts of plagioclase, the rock is essentially aphyric and consists of somewhat infrequent laths of plagioclase about 0.5 mm. in length with intervening sheafs of needles of plagioclase either with parallel or with somewhat radiate arrangement. About 3% of magnetite is present in small scattered octahedral crystals or in short strings of tiny crystals.

Besides chloritic minerals, the secondary minerals of all the rocks include cloudy "kaolin" and occasional yellow epidote. Minute veinlets of quartz or of quartz and calcite occasionally appear. The chloritic minerals include about equal proportions of green, poorly birefringent penninite and a deep-yellowish to reddish-yellow chlorite with high birefringence which possibly is clinochlore, but more probably is the green variety slightly oxidised to yield hematite; there is also a very small amount of a deep-bluish-green member of this same group of minerals.

The present writer (Bartrum, 1936b) has described spilitic pillow-lava and other albitic rocks from Great Island of the Three Kings group, but the rocks now recorded are not allied to these, but belong to the "Older Volcanic Series" of Bartrum and Turner (1928) which is extensive near North Cape on the mainland adjacent to Three Kings Islands and apparently is of Cretaceous age (Bartrum, 1934). This series includes altered quartz andesites which are very similar to those of the Three Kings islets.

In conclusion, the writer would thank Mr. Buddle for his interest in collecting the rocks from this inaccessible area and for his courtesy in submitting them for examination.

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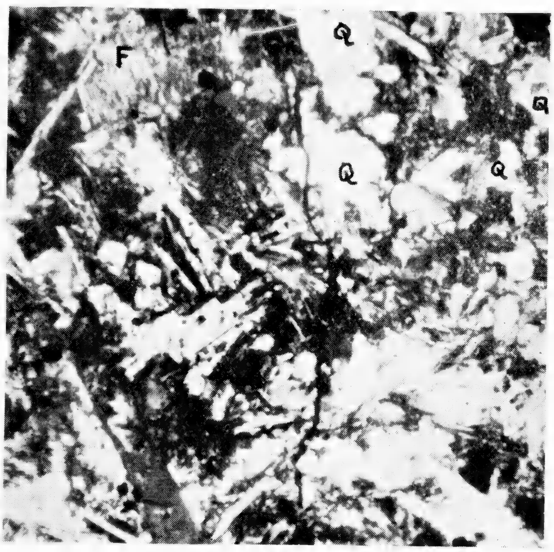


Fig. 1. Quartz andesite, Princes Rocks, Three Kings Islands. Typical texture. Grains of quartz (Q) are visible; chlorite (blackish) is here locally abundant, but plagioclase is the dominant constituent. X 64 diams. Nicols crossed.

Fig. 2. Quartz andesite, South West Island, Three Kings Islands. Much of the dark, granular material is chlorite. Quartz (Q) is locally abundant at upper right. The balance is mainly plagioclase; at F a sheaf of parallel needles of plagioclase. X 64 diams. Nicols crossed.

# Maori Carvings from the Three Kings Islands

By GILBERT ARCHEY, Director.

The carvings here described were discovered in April, 1946, by Messrs. M. and B. Chaney, members of the Internal Affairs Wild-life Branch expedition to exterminate the goats on the island.

The larger carving (Pl. 29) was recovered from a small cave or arched cavity about three feet high and ten feet deep at the ground level of a large outcrop rock; a similar cavity ten feet to the right contained three small rectangular boards, one with a lightly carved area (Pl. 30, fig. 1), a few human bones (lower jaws, ribs and vertebrae) and some locks of human hair; a small greenstone chisel was found by sifting the floor.

The larger carving is 106 cm. long and 53 cm. high; its thickness varies from 2 to 5 cm. at the top and a flange at the bottom projects about 3 cm. backwards. It is abraded and broken at both ends, so what length is missing can only be guessed; its height and the nature of the carving do, however, give some grounds for conjecture as to its purpose.

The carved figures, one full face and the other in profile, present an alternation of stance almost invariably followed in Maori carving when a long, narrow area is to be decorated with human figures. On the canoe wash-strake, for example (Pl. 30, fig. 4), there is such a succession; in this case the figures are recumbent and close together head to feet, forming a continuous band of carving. Other examples of this rhythmic alternation are the *paepae* of a house or food-store (Pl. 30, fig. 5) or the side of a *pataka,* but here again the *manaia* and *tiki,* now upright, usually stand close together. The figures stand apart on the barge-board (*maihi*) of a *pataka;* usually they are vertical and consequently oblique to the length of the *maihi,* though a few examples with the figures at right angles to the length are known (i.e., Copenhagen Museum); *maihi,* however, do not have a ridge on the lower edge. Another possibility is that the carving is part of a small *pare* or door lintel containing three figures; but *pare* have a clearly defined basal portion, usually undecorated, and the top curves downwards on either side of the central figure. The most likely conclusion would, therefore, seem to be that the carving is part of a *paepae* or of the side of a *pataka.*

In style the carving follows the North Auckland manner. Typically northern are the undecorated body, the partly decorated limbs with knees and elbows sharply angular, the long, tapering fingers and the pointed feet. The triangular full-face head with its sharp protruding tongue is unusual in the northern school, where a high, narrowing forehead is customary; triangular faces, or at least faces with broad foreheads, are, however, common in Taranaki carvings (Pl. 30, fig. 3). The pattern decorating the limbs is in the northern style, but is crude by com-

parison with the graceful movement of the finest work of this school (Pl. 30, fig. 2). Both figures have a sturdy quality, and one can well envisage the dynamic vigour expressed by the profile figure before deterioration and decay had set in.

The profile face of this *manaia* also has Taranaki tendencies. This is not to say that northern profile renderings were never of its type; too few examples are known to warrant a general statement; the only pieces known to me are the markedly aberrant Doubtless Bay and Awanui carvings I described in 1933, and the richly intricate canoe prow in the British Museum (Archey, 1933, Pl. 49, fig. 1), which, though generally attributed to North Auckland, actually has no recorded locality. The most that one can say on this point is that the Three Kings carving gives some support to the relationship between Northland and Taranaki carving noted by the writer in the paper referred to.

One of the smaller boards (Pl. 30, fig. 1) found in the second cavity has two projections at one end, one perforated by a rectangular mortice; another has a transverse groove near one end. These features doubtless have to do with fitting and tying, but I have not managed to fit the pieces together. Neither have I been able to discover any coherent pattern in the shallow carving on the first-mentioned piece. It is a medley of scrolls and loops typically northern in style; perhaps it is its incompleteness that hides whatever anatomical significance the pattern may hold.

With regard to the date of the work, all that can be affirmed is that it is earlier than 1840, when the last Maoris left the Three Kings Islands. Great Island was occupied when Tasman passed it in 1642 (Heeres, 1898) and inhabitants were seen by Marion du Fresne in 1772 (Roth, 1891, p. 23) and by D'Entrecasteaux in 1793 (Labillardière, 1800). North East Island has also had some degree of occupation; Major Buddle and Major Johnson, who hazardously achieved a landing early this year, found stone retaining walls for garden terraces similar to those on Great Island described by Mr. W. M. Fraser, 1929). The group appears to have been without inhabitants early in the last century, until a party of Maoris from Tom Bowling Bay reoccupied Great Island. These residents, who were visited by the Rev. Geo. Puckey in 1835 (Puckey, 1836), finally withdrew, as already stated, in 1840.

The wood of the carving has been identified by the State Forest Service as *totara*, which did not grow on the Three Kings. We have, however, no means of knowing whether the carving was done on Great Island or the mainland.

The fact that the carvings had been placed carefully in rock recesses together with mortuary remains, indicates that they were valued for some reason, probably as historical relics of some tribal event or personage. It is unfortunate that they are in such poor condition, particularly when it is just the defaced upper part of the larger carving that might have provided better evidence of its relationships. Nevertheless, they are welcome additions to our scant knowledge of northern carving styles.

For cultural reasons, this image has been removed. Please contact Auckland Museum for more information.

Carving from Great Island, Three Kings; probably part of a pataka side, or of a paepae.

I have pleasure in acknowledging information given to me by Mr. E. G. Turbott as to the manner in which these articles had been carefully set apart by their Maori owners, and the collation of historical details of the islands supplied by Mr. A. W. B. Powell.

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For cultural reasons, these images have been removed.
Please contact Auckland Museum for more information.

Fig. 1. Carved slab from Great Island, Three Kings; Auckland Museum.

Fig. 2. Burial chest, Bay of Islands; Auckland Museum.

Fig. 3. Carved slab from Taranaki; Taranaki Museum.

Fig. 4. Part of wash-strake of war-canoe Te-Toki-a-Tapiri; Auckland Museum.

Fig. 5. Carving from side of pataka from Maketu; Auckland Museum.

# The Flora of the Three Kings Islands.

By W. R. B. OLIVER, D.Sc., F.R.S.N.Z.

The Three Kings Islands form a small group lying about 40 miles to the north-west of Cape Maria van Diemen in the extreme north of New Zealand. They lie roughly in a line running W.S.W. to E.N.E. The largest island, Great Island, consists of two portions connected by a narrow isthmus on either side of which is a bay affording some shelter from westerly weather. This island has an undulating surface surrounded on all sides by high sea cliffs. The highest point is 990 feet above sea level. North East Island is a high, isolated rock which can be ascended in one place by a precipitous track. South West Island, reaching a height of 690 feet, lies to the W.S.W. of Great Island. A landing can be made provided the sea is not too rough. About W.S.W. from this islet is West Island, a high rock with precipitous, apparently unscalable, sides, and on which no one in quest of plants has ever landed. A row of jagged rocks, Princes Islets, lies between South West Island and West Island.

The rocks of the group are mainly greywacke, but andesite is found on some of the islands. The islands may be remnants of an extension of the north-west portion of New Zealand. Whether the present flora is descended from that which covered an area connected with the mainland of New Zealand, or has all arrived by drift, or by both means, is as yet impossible to say; but it is certain that the group has been isolated for a very long time as it contains several endemic species, including an endemic genus.

## BOTANICAL COLLECTIONS.

The first botanist to visit the Three Kings Islands was Mr. T. F. Cheeseman, Curator of the Auckland Museum. He landed on Great Island in August, 1887, from the Government steamer *Stella*. Cheeseman, in his account of the group, records 82 species of vascular plants. Apparently he did not collect specimens of all the species but relied largely on entering the names, as he recognised the species, in his notebook. In a few cases doubts have since arisen as to the identity of the species, but no specimens exist in his herbarium to settle them. Of the 82 species observed by Cheeseman during this visit 14 have not since been seen by any subsequent observer. Two years later, in November, 1889, Cheeseman again visited the Three Kings, this time in the Government steamer *Hinemoa*. His report on this trip gives the names of 60 species not mentioned in his first list, and, besides these, he mentions 24 other species. Cheeseman on this occasion landed on South West Island as well as on Great Island. As before, most of the species observed are not represented by specimens in his herbarium, and of the total number of 142 species recorded by Cheeseman, 50 have not subsequently been observed. The question as to whether the disappearance of these species

is due to the goats which from the time of Cheeseman's visits until 1946 were abundant on Great Island is discussed by Baylis and Turbott in this number of the *Records of the Auckland Museum.*

The next person to collect plants on the Three Kings was Mr. W. M. Fraser, Engineer to the Whangarei Harbour Board, who as a member of a party from Government House, stayed on Great Island for three days in December, 1928. The party was conveyed to and from the island by the Government steamer *Tutanekai.* Fraser collected or observed 26 species of which two were additions to the flora. His specimens are preserved in the Dominion Museum. In 1934 an expedition organised by the Auckland Museum visited the group in the auxiliary ketch *Will Watch.* Only two half days were spent ashore on Great Island. An attempt to land on South West Island failed. Botanical collections were made by Dr. Baylis, Mr. Turbott and myself, the specimens going to the Auckland and Dominion Museums. The number of species collected was 62, of which 9 were additions to previous lists. In November-December, 1945, Dr. Baylis was fortunate enough to be able to stay on Great Island for a week. He visited all parts of the island and gathered 83 species of plants for the Auckland Museum. Twelve were additions to previous lists. Baylis brought back four undescribed species (one of which was collected in 1934), including the remarkable discoveries of a species of *Tecomanthe,* which adds a family, Bignoniaceae, to the New Zealand flora, and a tree belonging to the family Anacardiaceae, another family not hitherto known from the New Zealand area.

In 1946 the New Zealand Government despatched a party to Great Island for the purpose of shooting the goats on the island. This they were successful in doing, 398 animals being killed. Mr. E. G. Turbott, of the Auckland Museum, accompanied this expedition and studied the vegetation. He and the four members of the goat killing party, L. C. Bell, M. and B. Chaney, and B. Meachen, collected for the Auckland Museum 62 species of plants, including the four new ones found by Dr. Baylis. Two of the species collected were new records for the island. Mr. Turbott marked out quadrats and carefully recorded their contents so that future botanists might watch the progress of the growth of the vegetation since the goats were exterminated. The last expeditions to the Three Kings were those made by Major M. E. Johnson and Major G. A. Buddle in Major Johnson's yacht in early January of both 1947 and 1948. Dr. Baylis accompanied the 1948 expedition and collected further material on Great Island. Landings were made on North East Island, South West Island, and the Princes Islets. Buddle collected or noted 26 kinds of plants, of which one was new for the group. His specimens are preserved in the Auckland Museum.

## GEOGRAPHICAL RELATIONSHIPS.

From the location of the Three Kings Islands it would naturally be expected that New Zealand species should form the bulk if not the whole o fthe flora. Of the 178 species which I have admitted to the list, 168 are found in New Zealand. Three Kings Islands and New Zealand examples of these species show no differences of importance

except in the case of *Coprosma macrocarpa.* In monographing this genus (1935) I associated with Three Kings examples specimens gathered from several localities in the North Auckland district because I could not detect any difference in the leaves. The fruits of the Three Kings plants are, however, considerably larger than those of any New Zealand mainland specimens so far collected.

Six endemic species of Three Kings plants belong to New Zealand genera and may accordingly be regarded as being evolved from New Zealand species which, at some time in the past, have reached the Three Kings group and there remained isolated. These species show that the period of effective isolation has been considerable, though all the species can be related to existing New Zealand species. The species in this group are: *Paratrophis smithii, Alectryon grandis, Pittosporum fairchildii, Suttonia dentata, Hebe insularis, Brachyglottis arborescens.*

There remain four species belonging to genera not represented on the New Zealand mainland, namely: *Davallia tasmani, Chloris truncata, Plectomirtha baylisiana,* and *Tecomanthe speciosa. Davallia* is a genus of tropical ferns, so that, in view of the facilities which ferns have in their spores for carriage by air, its presence in the Three Kings is not surprising. *Chloris* is a large genus of grasses distributed over the warmer regions of the world. *C. truncata* is widely diffused in Australia. *Plectomirtha* is founded in the present report to accommodate a species of the family Anacardiaceae which I am unable to place in any published genus. Its relatives may be looked for in the New Guinea-Melanesia region. *Tecomanthe* consists of 17 species ranging from the Moluccas to the Three Kings. The Three Kings plant is most closely related to the Queensland species *T. hillii.*

A fair conclusion from the facts would be that, with the exception of four species, the flora of the Three Kings has been derived from New Zealand. Probably many of the species have opportunities for crossing from the mainland to the islands, but in the case of the six endemic species isolation has been sufficiently long to enable the immigrants to develop along their own lines into peculiar species. The possibility of these or other species of New Zealand affinity being remnants of a flora that existed when, if ever, the Three Kings were joined to New Zealand, should be kept in view.

The presenc o fthe genra *Davallia, Chloris, Plectomirtha* and *Tecomanthe* is not explainable by derivation from New Zealand, or by land connection with any other country. In the present state of our knowledge, therefore, it must be assumed that they have been brought to the group accidentally by ocean currents, by storms or by birds, this last agent being extremely problematical. *Davallia* has light spores and could be carried by air currents. *Tecomanthe* is also suitable for air transport, as it has winged eeds. The seeds of *Chloris* might be carried by the ocean current which sets eastward from the Australian coast towards New Zealand. *Plectomirtha* probably has a succulent fruit, as has its relative *Semecarpus.*

The species of introduced plants found in the Three Kings Islands show that ocean currents or wind or both are effective agents in transferring seeds from the mainland of New Zealand. Of the 10 species listed, 5 are grasses and 4 composites, families that seem to be prone to spreading widely by means of water and air currents.

### ACKNOWLEDGMENTS.

In writing this paper I wish to record my sincere thanks for the generous assistance I have received from Mr. E. G. Turbott, Dr. G. T. S. Baylis, and Major G. A. Buddle; all of whom have permitted me to see their papers in manuscript form. Miss B. E. G. Molesworth, Botanist in the Auckland Museum, has been particularly helpful in replying to my numerous inquiries regarding the specimens in the Auckland Museum from the Three Kings under her care. For the photographs I have to thank Dr. Baylis, Mr. Turbott, and Mr. B. W. Hall, Photographer in the Dominion Museum.

## PTERIDOPHYTA

### FAMILY HYMENOPHYLLACEAE.

**Mecodium sanguinolentum** (Forst. f.) Presl.

Three Kings Is. Cheeseman, 1889 (*Hymenophyllum*).

### FAMILY CYATHEACEAE.

**Cyathea medullaris** Sw.

Great Island. Cheeseman, 1887—"a few tree ferns were noticed." Cheeseman, 1889—"along the edges of the stream were several fern trees." Fraser, 1928—"black tree fern . . . in places on the northern side of Tasman Valley." Baylis, 1945—"A few along the Tasman Stream amongst forest remnants."

### FAMILY SCHIZAEACEAE.

**Schizaea fistulosa** Lab.

Great Island. Baylis, 1945 (AM).

### FAMILY POLYPODIACEAE.

**Polystichum richardi** (Hook.) Sm.

Great Island. Cheeseman, 1887—"plentiful."

**Cyclosorus pennigera** (Forst. f.) Copel.

Great Island. Oliver, 1934 (DM).

**Arthropteris tenella** (Forst. f.) J. Sm.

Three Kings Is. Cheeseman, 1889.

**Davallia tasmani** Field.

*Davallia* sp., Cheesem., *Trans. N.Z. Inst.*, 20, 148, 1888. *D. tasmani* Field, *Ferns N.Z.*, 75, 1890, Three Kings Is., type specimen in Auckland Museum, No. 419/1; Baker, *Ann. Bot.*, 5, 201, 1890; Cheeseman, *Trans. N.Z. Inst.*, 23, 416, 1891; *Man. N.Z. Fl.*, 955, 1906; *Illustr. N.Z. Fl.*, 2, pl. 237, 1914; *Man. N.Z. Fl.*, Ed. 2, 41, 1925. Great Island. Cheese-

man, 1887—"on some rocky ledges near the top of the cliffs a handsome fern new to New Zealand was collected." Cheeseman, 1889 (AM, DM). Baylis, 1945 (AM). Cheeseman records for his 1889 visit to Great Island: "Wherever the tea tree attains a little higher growth than usual, and consequently affords more shade, the new *Davallia* discovered in my previous visit abounds." South West Island. Cheeseman, 1889—"*Davallia tasmani* was plentiful, attaining a greater size than on the main island of the group." Buddle, 1947 (AM). North East Island. Buddle, 1947 (AM).

**Asplenium falcatum** (Lam.) Copel.
Three Kings Islands. Cheeseman, 1889.

**Asplenium obtusatum** Forst. f.
Great Island. Cheeseman, 1887. Oliver, 1934 (DM). Baylis, 1934 (AM). Turbott, 1946 (AM)—on ledge close to sea level at north-west landing.

As usual with this species there are different forms of pinnae. In general the side pinnae are rounded at the tip and the terminal pinna has a pointed apex. In one specimen (Baylis, 1934) the pinnae are all acute, in another of the same collection one leaf has the lower pinnae rounded and the upper ones, including the terminal, acute.

**Asplenium lucidum** Forst. f.
South West Island. Cheeseman, 1889—"This and *Pteris comans* are the most abundant ferns in the undergrowth."

**Asplenium flaccidum** Forst. f.
Great Island. Cheeseman, 1887—"plentiful." Baylis, 1945 (AM) —rupestral.

**Blechnum norfolkianum** (Hew.) C. Chr.
Great Island. Cheeseman, 1887 (*Lomaria acuminata*). Cheeseman, 1889 (AM). Fraser, 1928 (DM) (*B. lanceolatum*). Oliver, 1934 (DM). Baylis, 1945 (AM).

All specimens have the long, pointed, falcate pinnae characteristic of *norfolkianum,* although it must be admitted that the line between *norfolkianum* and *lanceolatum* is rather indefinite.

**Blechnum procerum** (Forst. f.)
Great Island. Cheeseman, 1887—"plentiful." Oliver, 1934 (DM). Baylis, 1945 (AM)—Fertile pinnae quite irregular, in some the base only, in others the middle section being fertile.

**Doodia media** R. Br.
Great Island. Cheeseman, 1887—"plentiful." Oliver, 1934 (DM). Baylis, 1934 (AM)—"a common fern beneath kanuka both on hills and gullies." Baylis, 1945 (AM). Turbott, 1946 (AM)—under kanuka, scattered sparsely, reddish and flatter in open.

**Pellaea rotundifolia** (Forst. f.) Hook.
Three Kings Islands. Cheeseman, 1889.

**Cheilanthes sieberi** Kze.
Great Island. Baylis, 1947.

**Hypolepis tenuifolia** (Forst. f.) Bernh.
Three Kings Islands. Cheeseman, 1889. Great Island, Fraser, 1928 (DM).

**Adiantum affine** Willd.
Great Island. Cheeseman, 1887. Oliver, 1934 (DM). Baylis, 1945 (AM).

**Adiantum hispidulum** Sw.
Great Island. Cheeseman, 1887. Oliver, 1934 (DM). Baylis, 1934, 1945 (AM).

**Pteris tremula** R. Br.
Great Island. Cheeseman, 1887—"plentiful." Baylis, 1947.

**Pteris comans** Forst. f.
Great Island. Cheeseman, 1887—"plentiful." Cheeseman, 1889 (AM). Fraser, 1928 (DM). Oliver, 1934 (DM). Segments comparatively small, none over 30 by 8 mm., all sterile, conspicuously shorter and more blunt than in specimens from the Kermadecs and New Zealand. Baylis, 1934 (AM)—not infrequent in gullies. Baylis, 1945 (AM)—sori continuous except at tip. Turbott, 1946 (AM).

**Pteridium esculentum** (Forst. f.) Ckne.
Great Island. Cheeseman, 1887—"The vegetation on top of the island is mainly composed of stunted tea tree mixed with flax, common fern (*Pteris aquilina*) and sedges." Baylis, 1945 (AM). North East Island. Buddle, 1947.

**Pyrrosia serpens** (Forst. f.) Ching.
Great Island. Cheeseman, 1887. Turbott, 1946 (AM)—"8 feet above ground in a kanuka." North East Island. Buddle, 1947 (AM).

**Microsorium diversifolium** (Willd.) Copel.
Great Island. Cheeseman, 1887 (*Polypodium*)—"plentiful." Oliver, 1934 (DM). Baylis, 1945 (AM).

### FAMILY LYCOPODIACEAE.

**Lycopodium volubile** Forst. f.
Great Island. Cheeseman, 1887.

## SPERMOPHYTA

### FAMILY GRAMINEAE.

**Zoisia matrella** (L.) Merril.
Great Island. Baylis, 1945 (AM). There are two growth forms. (a) erect, up to 23 cm. tall; (b) prostrate, matted, stems up to 3 cm. in length. Turbott, 1946 (AM).

**Paspalum scrobiculatum** L.
Three Kings Islands. Cheeseman, 1889.

**Oplismenus undulatifolius** Beauv.
Great Island. Cheeseman, 1887 (*Panicum imbecile*). Oliver, 1934 (DM). Baylis, 1934 (AM). Turbott, 1946 (AM). North East Island. Buddle, 1947 (AM).

**Microlaena stipoides** R. Br.
Great Island. Baylis, 1947.

**Echinopogon ovatus** (Forst. f.) Beauv.
Great Island. Cheeseman, 1887. Fraser, 1928 (DM). Oliver, 1934 (DM). Baylis, 1934 (AM). Turbott, 1946 (AM).

**Deyeuxia filiformis** (Forst. f.) Hook.
Three Kings Islands. Cheeseman, 1889 (*Agrostis aemula*). Great Island. Baylis, 1934 (AM). North East Island. Buddle, 1947.

**Deyeuxia billardieri** (R. Br.) Kunth.
Three Kings Is. Cheeseman, 1889. Great Island. Baylis, 1948.

**Deyeuxia crinita** (L.) Zotov.
Three Kings Islands. Cheeseman, 1889. Great Island. Baylis, 1934, 1945 (AM). Turbott, 1946 (AM).

**Danthonia semiannularis** R. Br.
Three Kings Islands. Cheeseman, 1889. Great Island. Oliver, 1934 (DM). Baylis, 1934 (AM).

**Chloris truncata** R. Br.
Great Island. Baylis, 1948. Not hitherto recorded in the New Zealand region.

**Arundo kakao** Steud.
Great Island. Cheeseman, 1887 (*A. conspicua*). South West Island. Cheeseman, 1889—"above gannet colony." West Island. Cheeseman, 1889.

**Poa anceps** Forst. f.
Great Island. Cheeseman, 1887. Baylis, 1945, 1947 (AM).

**Poa seticulmis** Petrie.
Baylis, 1945 (AM). Turbott, 1946 (AM).

**Agropyrum kirkii** Zotov.
Great Island. Baylis, 1948.

## FAMILY CYPERACEAE.

**Cyperus ustulatus** A. Rich.
Three Kings Islands. Cheeseman, 1889. Great Island. Fraser, 1928 (DM). This seems to differ from the New Zealand plant only in being larger. The stems are more robust and there are more and larger spikes in each umbel. Stems over 1 m. tall, umbels 16 cm. long, of about 12 spikes. Baylis, 1945 (AM). Turbott and Bell, 1946 (AM). South West Island. Buddle, 1947 (AM).

**Eleocharis acuta** R. Br.
Great Island. Baylis, 1945 (AM)

**Scirpus cernuus** Vahl.

Three Kings Islands. Cheeseman, 1889 (*Isolepis riparia*). Great Island. Oliver, 1934 (DM). Baylis, 1945 (AM)—very slender, 12 cm. tall. Turbott and Bell, 1946 (AM).

**Scirpus inundatus (R. Br.) Poir.**

Great Island. Baylis, 1945 (AM).

**Scirpus nodosus** Rottb.

Great Island. Cheeseman, 1887. Oliver, 1934 (DM). Baylis, 1945 (AM). Turbott and Bell, 1946 (AM).

**Schoenus foliatus (Hook. f.) Blake.**

Three Kings Islands. Cheeseman, 1889 (*S. axillaris*). Great Island. Baylis, 1945 (AM).

**Cladium rubiginosum (Forst. f.) Druce.**

Great Island. Baylis, 1945 (AM).

**Cladium teretifolium R. Br.**

Great Island. Cheeseman, 1887.

**Cladium junceum R. Br.**

Great Island. Oliver, 1934 (DM). Baylis, 1945 (AM).

**Gahnia gahniaeformis (Gaud.) Heller.**

Three Kings Islands. Cheeseman, 1889 (*G. arenaria*).

**Uncinia uncinata (L.) Kirk.**

Great Island. Cheeseman, 1887 (*U. australis*).

**Carex virgata** Hook. f.

Great Island. Cheeseman, 1887. Oliver, 1934 (DM). Baylis, 1945 (AM). Turbott, 1946 (AM).

**Carex ternaria** Forst. f.

Three Kings Islands. Cheeseman, 1889.

**Carex testacea** Boott.

Great Island. Cheeseman, 1887. Fraser, 1928 (DM). Oliver, 1934 (DM). Turbott, 1946 (AM).

**Carex lucida** Hook. f.

Great Island. Baylis, 1945 (AM).

**Carex solandri** Hook. f.

Three Kings Islands. Cheeseman, 1889 (*C. neesiana*).

**Carex breviculmis** R. Br.

Great Island. Cheeseman, 1887. Oliver, 1934 (DM). Baylis, 1945 (AM).

**Carex forsteri** Wahl.

Three Kings Islands. Cheeseman, 1889 (AM). In one specimen there are 5 terminal male spikelets. Great Island. Baylis, 1945 (AM). North East Island. Buddle, 1947 (AM).

## FAMILY JUNCACEAE.

**Juncus vaginatus** R. Br.
Great Island. Oliver, 1934 (DM). Baylis, 1945 (AM).

**Juncus polyanthemos** Buch.
Three Kings Islands. Cheeseman, 1889 (*J. communis*).

**Juncus bufonius** L.
Three Kings Islands. Cheeseman, 1889.

**Luzula campestris** DC.
Three Kings Islands. Cheeseman, 1889.

## FAMILY LILIACEAE.

**Cordyline australis** (Forst. f.) Hook. f.
Great Island. Cheeseman, 1887. Fraser, 1928—"Cabbage trees grow to large dimensions, with many branches bearing heads of very large leaves, and flowering profusely, were found near running streams facing the east." (*N.Z. Jour. Sci. Tech.*, 11, 152, 1929). Oliver, 1934 (DM). Baylis, 1945 (AM). Turbott, 1946 (AM)—"Somewhat stunted tree, above western cliffs. White fruit, 18th April." South West Island. Cheeseman, 1889—"above gannet colony, short stemmed. Luxuriant specimens in sheltered places, mixed with *Meryta sinclairii*." North East Island. Cheeseman, 1889—"Cabbage trees were seen," from deck of *Hinemoa*.

**Collospermum hastatum** (Col.) Skottsb.
Great Island. Baylis, 1945 (AM).

**Dianella intermedia** Endl.
Great Island. Cheeseman, 1887. Baylis, 1945 (AM).

**Phormium tenax** Forst.
Great Island. Cheeseman, 1887—"above north landing, patches of flax (*P. tenax*) alternating with tea tree and toetoe. The vegetation on the top of the island is mainly composed of stunted tea tree, mixed with flax (*P. tenax*), fern and sedges." South West Island. Cheeseman, 1889—"above gannet colony." Buddle, 1947 (*Phormium* sp.). West Island. Cheeseman, 1889—"Stunted flax on top of West Island seen from deck of *Hinemoa*." Princes Islets. Buddle, 1947 (*Phormium* sp.).

**Phormium colensoi** Raoul.
Three Kings Islands. Cheeseman, 1889. Some records under *P. tenax* may refer to this species.

**Arthropodium cirrhatum** (Forst. f.) R. Br.
Great Island. Cheeseman, 1887. Fraser, 1928 (DM)—"On the cliff at Tasman Falls and overhanging the pool immediately above the falls." Turbott and Bell, 1946—quite common, north and west cliff faces.

## FAMILY ORCHIDACEAE.

**Thelymitra longifolia** Forst.
Great Island. Cheeseman, 1887. Baylis, 1945 (AM).

**Microtis unifolia** (Forst. f.) Reich.
Great Island. Cheeseman, 1887. Baylis, 1945 (AM).

**Acianthus fornicatus** R. Br. var. **sinclairii** (Hook. f.) Hatch.
Great Island. Cheeseman, 1887.

**Caladenia carnea** R. Br., var. **minor** (Hook. f.) Hatch.
Great Island. Baylis, 1945 (AM).

**Pterostylis trullifolia** Hook. f.
Great Island. Baylis, 1948.

## FAMILY PIPERACEAE.

**Macropiper excelsum** (Forst. f.) Miq. var. **major** Cheesem.
Great Island. Cheeseman, 1887. Cheeseman, 1889 (AM). Turbott and Bell, 1946—"practically inaccessible place down cliff, north coast." South West Island. Cheeseman, 1889—"large leaved form of the kawakawa, so common at the Kermadec Islands, forming undergrowth in forest of *Meryta sinclairii* and *Cordyline australis*." Buddle, 1947 (AM). North East Island. Buddle, 1947.

**Peperomia urvilleana** A. Rich.
Great Island. Cheeseman, 1887. Baylis, 1945 (AM).

## FAMILY MORACEAE.

**Paratrophis smithii Cheesem.**
*Trans. N.Z. Inst.*, 20, 148, 1888. Great Island, Three Kings Is., type specimen in Auckland Museum; *Man. N.Z. Fl.*, 633, 1906; Ed. 2, 379, 1925. Great Island. Cheeseman, 1887 (AM, DM). Fraser, 1928 (DM).—"in sheltered localities facing eastward." Oliver, 1934 (DM). Turbott, 1934 (AM). Baylis, 1934 (AM). Baylis, 1945 (AM). Turbott and Bell, 1946 (AM). South West Island. Cheeseman, 1889 (AM)—"particularly abundant, especially towards the summit of the island, forming a bush a few feet in height, with flexuous and closely interlaced branches, and presenting a very different appearance from the tall, slender, sparingly branched form seen in the gullies of the Great King." Buddle, 1947 (AM). North East Island. Buddle, 1947 (AM).

The present occurrence of this species on Great Island seems to be about the same as at the time of Fraser's visit. The largest leaf I have measured (Fraser, 1928) is 235 by 115 mm., the next largest (Turbott and Bell, 1946) 221 by 115 mm. The petioles are short, 10 to 15 mm. long, thick and curved.

## FAMILY URTICACEAE.

**Parietaria debilis** Forst. f.
Great Island. Cheeseman, 1887. Baylis, 1945 (AM). Turbott, 1946 (AM)—"probably grown since our arrival: goats much reduced in numbers within a week." North East Island. Buddle, 1947.

## FAMILY POLYGONACEAE.

**Muehlenbeckia australis (Forst. f.) Meissn.**
South West Island. Cheeseman, 1889 (*M. adpressa*).

**Muehlenbeckia complexa (A. Cunn.) Meissn.**
Great Island. Cheeseman, 1887. Oliver, 1934 (DM). Baylis, 1945 (AM). North East Island. Buddle, 1947. In all the specimens the leaves are obovate, widest above the middle, apex obtuse, mucronate. Largest leaf (Oliver, 1934) 25 by 20, petiole 8 mm. Leaves from Karewa Island, Bay of Plenty, are very similar in shape but much smaller.

## FAMILY CHENOPODIACEAE.

**Salicornia australis** Forst. f.
Great Island. Baylis, 1945 (AM) South West Island. Cheeseman, 1889 (*S. indica*)— "Edges of cliffs on either side of gannet colony."

**Rhagodia nutans** R. Br.
Great Island. Oliver, 1934 (DM). Baylis, 1945 (AM). Turbott and Bell, 1946 (AM). South West Island. Cheeseman, 1889—"Edges of cliffs on either side of gannet colony." North East Island. Buddle, 1947 (AM). Princes Islets. Buddle, 1947 (AM).

**Chenopodium triandrum** Forst. f.
Great Island. Baylis, 1947.

## FAMILY MIRABILIDACEAE.

I have previously (*Trans. Roy. Soc. N.Z.*, 66, 294, 1936) used this name for the family, as *Nyctago* is a synonym of *Mirabilis*.

**Hiemerliodendron brunoniana (Endl.) Skottsb.**
Great Island. Cheeseman, 1887—"Above north landing. A few small trees of the rare *Pisonia umbellifera* were noticed." Cheeseman, 1889—"On cliffs. Here and there may be seen small clumps of the *parapara* (*P. brunoniana*). Turbott and Bell, 1946 (AM)—north cliff face. Turbott, 1946 (AM)—from a single tree in third valley to north-east from depot. Turbott and Bell, 1946 (AM)—northern cliff face.

## FAMILY AIZOACEAE.

**Disphyma australe** (A. Cunn.) Black.
Great Island. Cheeseman, 1887 (*Mesembryanthemum*). Baylis, 1945 (AM). South West Island. Cheeseman, 1889—"Edges of cliffs on either side of gannet colony." North East Island. Buddle, 1947. Princes Islets. Buddle, 1947 (AM).

**Tetragonia expansa** Murr.
Three Kings Islands. Cheeseman, 1889.

**Tetragonia trigyna** Hook. f.
Three Kings Islands. Cheeseman, 1889. Great Island. Turbott and Bell, 1946 (AM)—northern cliff face. North East Island. Buddle, 1947.

## FAMILY CARYOPHYLLACEAE.

**Stellaria parviflora** Hook. f.
Three Kings Islands. Cheeseman, 1889.

**Spergularia marginata** Kittel.
Great Island. Cheeseman, 1887 (*S. rubra*)—near shore, north landing. Turbott and Bell, 1946 (AM)—"Ledge close to sea level at north-west landing. Cliff top in clay north-east point of island."

**Scleranthus biflorus** (Forst.) Hook. f.
Three Kings Islands. Cheeseman, 1889.

## FAMILY RANUNCULACEAE.

**Clematis indivisa** Willd.
Great Island. Cheeseman, 1887. Baylis, 1934 (DM)—"A few plants among patches of trees in gullies." Baylis, 1945 (AM). Turbott, 1946 (AM).

**Clematis parviflora** A. Cunn.
Great Island. Cheeseman, 1887.

**Ranunculus hirtus** Forst. f.
Three Kings Islands. Cheeseman, 1889 (*R. plebeius*). Great Island. Oliver, 1934 (DM). Baylis, 1945 (AM)

## FAMILY MONIMIACEAE.

**Hedycarya arborea** Forst.
Great Island. Cheeseman, 1887 (*H. dentata*). Cheeseman, 1889—"plentiful in the valley." Oliver, 1934 (DM). Baylis, 1945 (AM). Turbott and Bell, 1946 (AM)—"South branch, upper Tasman Stream. Tree about 10 to 12 feet." Largest leaf 145 by 76 mm., petiole, 21 mm.

## FAMILY LAURACEAE.

**Litsaea calicaris** (A. Cunn.) Hook. f.
Great Island. Cheeseman, 1887—"a few small trees, in the valley." Fraser, 1928 (DM). Oliver, 1934 (DM)—in forest by Tasman Stream, unripe fruit. Baylis, 1945 (AM). Turbott and Bell, 1946 (AM)—"valley above depot in kanuka. In group of trees, northern cliff face, with large leaved tree." [*Plectomirtha*]

## FAMILY CRUCIFERAE.

**Cardamine heterophylla** (Forst. f.) Schultz.
Great Island. Cheeseman, 1887 (*C. hirsuta*). Baylis, 1934, 1945 (AM).

**Lepidium oleraceum** Forst. f., var. **frondosum** T. Kirk.
South West Island. Cheeseman, 1889 (AM)—"Here and there patches of Captain Cook's scurvy grass (*L. oleraceum*) were growing vigorously on the highly manured ground" [of the gannet colony]. Princes Islets. Buddle, 1947 (AM). Great Island. Baylis, 1948.

## FAMILY DROSERACEAE.

**Drosera auriculata** Planch.

Three Kings Islands. Cheeseman, 1889.

## FAMILY CRASSULACEAE.

**Tillaea sieberiana** Schultz.

Three Kings Islands. Cheeseman, 1889 (*T. verticillata*). Great Island. Baylis, 1934 (AM).

## FAMILY PITTOSPORACEAE.

**Pittosporum fairchildii** Cheesem.

*Trans. N.Z. Inst.*, 20, 147, 1888, Great Island, Three Kings Islands, type specimen in Auckland Museum; Kirk, *Stud. Fl. N.Z.*, 51, 1899; Cheeseman, *Man. N.Z. Fl.*, 58, 1906; Ed. 2, 493, 1925. Great Island. Cheeseman, 1887 (AM, DM)—above north landing. Cheeseman, 1889—"not uncommon, on the cliffs growing in a much more compact form than in the gullies." Fraser, 1928 (DM)—"Where the slopes are broken with boulders *P. fairchildii* grows abundantly." Branchlets woolly. Upper surface of leaf nearly glabrous, under surface with scant wool all over. This gets rubbed off in older leaves. Edge of leaf with thickened margin. Leaf blade 67 by 34 mm., petiole 7 mm. Turbott, 1934 (AM). Baylis, 1945 (AM). Turbott and Bell, 1946 (AM)—"Seaward slopes south of Crater Head. Green fruits, black seeds, yellow mucus."—E.G.T. North East Island. Buddle, 1947 (AM).

## FAMILY ROSACEAE.

**Rubus cissoides** A. Cunn.

Three Kings Islands. Cheeseman, 1889 (*R. australis*).

**Acaena anserinaefolia** (Forst.) Druce.

Three Kings Islands. Cheeseman, 1889 (*A. sanguisorbae*).

## FAMILY GERANIACEAE.

**Geranium dissectum** L., var. **glabratum** Hook. f.

Three Kings Islands. Cheeseman, 1889. Great Island. Baylis, 1934 (AM). Turbott, 1946 (AM).

**Pelargonium inodorum** Willd.

Three Kings Islands. Cheeseman, 1889. Great Island. Baylis, 1947.

## FAMILY OXALIDACEAE.

**Oxalis corniculata** L.

Great Island. Cheeseman, 1887. Oliver, 1934 (DM)—small, matted plant, small leaves with ciliate margins. Baylis, 1934, 1945 (AM). Turbott, 1946 (AM)—Cliff face near depot; larger than common form.

## FAMILY LINACEAE.

**Linum monogynum** Forst. f.

Three Kings Islands. Cheeseman, 1889.

## FAMILY RUTACEAE.

**Melicope ternata** Forst.

Great Island. Cheeseman, 1887—"a few small trees in the valley." Cheeseman, 1889—"plentiful in the valley." Fraser, 1928 (DM)—"About the stone heaps and *whare* sites of the old-time inhabitants.' Oliver, 1934 (DM). Baylis, 1934 (AM)—fairly common on cliffs. Baylis, 1945 (AM). Turbott, 1934 (AM)—eastern section of island. Turbott and Bell, 1946 (AM)—seaward slopes south of Crater Head. South West Island. Cheeseman, 1889. Buddle, 1947. North East Island. Buddle, 1947 (AM).

## FAMILY CALLITRICHACEAE.

**Callitriche muelleri** Sond.

Great Island. Baylis, 1945 (AM).

## FAMILY CORIARIACEAE.

**Coriaria arborea** Lindsay.

Great Island. Cheeseman, 1887 (*C. ruscifolia*).

## FAMILY ANACARDIACEAE.

### PLECTOMIRTHA Oliver, n. gen..

Tree.—Leaves alternate, entire. Flowers hermaphrodite, in panicles usually below the terminal leaves but sometimes terminal, bracts minute. Calyx disc-like, with 5 minute points opposite the stamens. Petals 5, deciduous. Stamens 5, alternating with the petals, filaments folded in the unopened flower. Ovary one-celled, ovule single, suspended from the top. Stigmas 3, sessile, united, forming a broad, flat disc.

Type species: *Plectomirtha baylisiana* Oliver, Three Kings Islands.

Arbor. Folia alternata, integra. Flores hermaphroditi, paniculati, plerumque infra folia terminales, nonnumquam terminales. Calyx disciformis, depressus. Petalae 5, deciduae. Stamina 5, petalis alternata, filamentis in floribus non apertis inflectis. Ovarium unicum ab apice loculi descendens. Stigmata 3, sessiles, conjunctae. Fructus ignotus.

Affinis *Semecarpus* sed differt floribus hermaphroditis, filamentis inflectis, stigmatis latis, sessilibus, conjunctis.

The discovery by Dr. G. T. S. Baylis on the Three Kings Islands of the present species adds a new genus to the flora of the New Zealand region; also a new family, for when *Corynocarpus* was made the type of a family, Anacardiaceae disappeared from the New Zealand list. It is now restored as a member of the New Zealand flora.

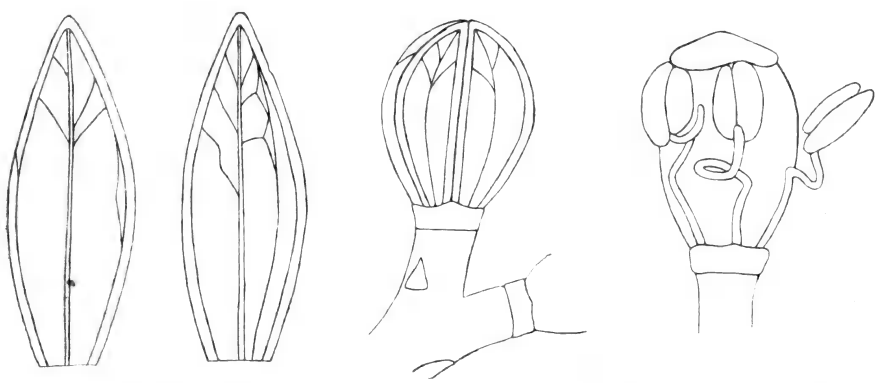
*Plectomirtha* falls within the family Anacardiaceae but differs in important points from all the other described genera. Apparently it stands next to *Semecarpus*, but differs from that genus in the bisexual

flowers, absence of disc, and especially by the broad, sessile, compound stigma. Its relation to *Semecarpus* rests on the simple leaves, unilocular ovary with single suspended ovule, three styles (sometimes united in *Semecarpus*) and superior pistil. The fruit collected was quite unripe. The long, folded filaments may occur in other genera where the stamens are longer than the petals. Capitate stigmas, less fused than in *Plectomirtha*, are found in some other genera (*Microstemon, Sorinderia*). Bisexual flowers are occasional in the family.

**Plectomirtha baylisiana Oliver,** n. sp.

Tree with spreading head. Branchlets stout, pale brown, covered with conspicuous lenticels, flattened and expanded where the leaves are inserted. Thickness of branchlets 6-7 mm. or more. The youngest branchlets are much smoother, apparently greenish, and have fewer inconspicuous lenticels.

Leaves alternate, glabrous, mostly in clusters at the ends of stout branchlets. Petiole short, stout; lamina obovate, widest above the middle, base rounded or cuneate, apex rounded or almost truncate; margin entire; midrib strong, 4 or 5 strong lateral nerves on either side arching forward and connecting with the nerve on each side by a submarginal loop; coriaceous. On the under surface n the angles at the junctions of midrib and lateral nerves are domatia lined with white bristles which extend a little way along the nerves. Measurements of leaves: lamina 250 x 156, petiole 30 mm.; lamina 228 x 140, petiole 25 mm.



Text figs. 1-4. *Plectomirtha baylisiana.* 1 and 2 petals, 3 unopened flower, 4 flower with petals removed.

Panicles single and terminal, or more often one or two below the leaves, much shorter than the leaves, about 10 cm. long, with long stalk and much branched head; sparse, minute, appressed hairs on the ultimate branches; bracts small, acuminate, margin bristly. Flowers numerous.

Calyx disc-like, defined below by a groove, upper margin with 5 minute points opposite the stamens. Petals 5, covering the stamens and pistil but apparently falling away soon after the flower opens; lanceolate,

with truncate base; midrib and submarginal nerves with secondary nerves towards the apex. Stamens 5, inserted with the petals and alternating with them. Filaments longer than the petals, bent once or twice in the unopened flower. Anthers large; lobes unequal, dehiscing by longitudinal slits. Ovary single, sessile, ovate. Ovule single, attached at the top. Stigmatic disc large, sessile, consisting of the conjoined three stigmas.

Type specimen in the Auckland Museum, collected by G. T. S. Baylis on Great Island, Three Kings Group, December 2nd, 1945.

Arbor. Folia glabra, obovata, apice rotundata vel truncata, base cuneata, coriacea. Paniculi axillares interdum terminales, foliis brevoir, bracteis minutis, acuminatis, ciliatis. Calyx disciformis, minutissime 5 lobatus. Petalae 5, deciduae, lanceolatae, base truncatae. Stamina 5, petalis alternata, filamentis in floribus non apertis inflectis, antheris inaequilateralibus. Ovarium uniloculare, ovatum. Ovulum unicum, ab apice loculi descendens. Stigmata 3, sessiles, conjunctae, latae, planae.

Baylis, who discovered this species, made the following notes: "A small tree about 15ft. high. Trunk forked at the base, rather slender, smooth, greyish. Crown wide-spreading, rounded, dense. Leaves dark green, extremely glossy, thin and flat in shade, in strong light smaller and curled backward so that adaxial surface is convex. Inflorescences freely produced on the stems below the leaves, rarely terminal. Perianth and stamens caducous. They had fallen from the flowers except those of the single terminal inflorescence collected. Ripe fruit not seen" (Dec. 2, 1945). Further notes on this same tree were made by E. G. Turbott as follows: "One tree 12ft. high. Branches into four trunks, two 6in., two 4in. diam. Where shoots die, new vertical shoots spring up." The leaves of both Baylis' and Turbott's specimens were badly eaten by insects.

Great Island.—"Only one tree found. On a steep scree of large greywacke boulders facing the sea and about 700ft. above it. Associated with pohutukawa, *Leptospermum ericoides, Olea apetala, Melicope ternata*" (Baylis). Baylis, 1945 (AM). Turbott, 1946 (AM).

## FAMILY CORYNOCARPACEAE.

**Corynocarpus laevigata** Forst.

Great Island. Cheeseman, 1889—"On the cliffs. A few *karaka* trees were scattered in sheltered nooks." Fraser, 1928—"About stone heaps and *whare* sites of the old-time inhabitants the *karaka* is found and had probably been brought to the island for food purposes. (*N.Z. Jour. Sci. Tech.*, 11, 152, 1929). Oliver, 1934 (DM). Turbott, 1934 (AM). Baylis, 1934, 1945 (AM). Turbott and Bell, 1946 (AM), Tasman Valley. North East Island. Buddle, 1947.

## FAMILY SAPINDACEAE.

**Alectryon grandis** Cheesem.

*Alectryon excelsum*, var. *grandis* (name only) Cheeseman, *Trans. N.Z. Inst.*, 23, 418, 1891; Cheeseman, *l.c.* 24, 409, 1892;

Cheeseman, *Man. N.Z. Flora,* 103, 1906. *Alectryon grandis* Cheeseman, *Trans. N.Z. Inst.,* 44, 159, 1912; Cheeseman, *Man. N.Z. Flora,* 552, 1925.

Great Island. Cheeseman, 1889 (AM)—"A small clump growing on the cliffs on the northern side of the Great King." Oliver, 1934 (DM). Baylis, 1934 (AM)—"two trees on cliff above North-west Bay." Baylis, 1945 (AM)—"A single moribund tree on cliffs above landing, North-west Bay." Turbott and Bell, 1946 (AM).

## FAMILY ELAEOCARPACEAE.

**Aristotelia serrata (Forst.) Oliver.**
Three Kings Islands. Cheeseman, 1889.

## FAMILY TILIACEAE.

**Entelea arborescens R. Br.**
Three Kings Islands. Cheeseman, 1889. Great Island. Oliver, 1934 (DM). Baylis, 1934 (AM)—"One miserable goat eaten remnant over tributary to Tasman."

## FAMILY VIOLACEAE.

**Melicytus ramiflorus Forst.**
Great Island. Cheeseman, 1887—"A few small trees, in the valley." Cheeseman, 1889 (AM). Fraser, 1928—"About the stone heaps and *whare* sites of the old-time inhabitants" (*N.Z. Jour. Sci. Tech.,* 11, 152, 1929). Oliver, 1934 (DM)—Three specimens with lanceolate leaves, one with broad elliptic leaves. Turbott, 1934 (AM). Baylis, 1934, 1945 (AM). Turbott, 1946 (AM)—by tributary of Tasman. One specimen with broad leaves with prominent teeth, 104 by 51 mm., petiole 20 mm, others 88 by 45 mm.

**Hymenanthera novae-zelandiae (A. Cunn.) Hemsl.**
Great Island. Cheeseman, 1887 (*H. latifolia*), north landing. Fraser, 1928 (DM)—"Where the slopes are broken with boulders *H. novae-zelandiae* grows abundantly." Baylis, 1945 (AM). Turbott and Bell, 1946 (AM)—northern cliff face. South West Island. Cheeseman, 1889 (AM)—above gannet colony. Buddle, 1947 (AM). North East Island. Buddle, 1947.

## FAMILY PASSIFLORACEAE.

**Tetrapathaea tetrandra (DC.) Cheesem.**
Great Island. Fraser, 1928 (DM). Compared with New Zealand specimens this has very broad deltoid leaves, with rather blunt tips. Baylis, 1945 (AM). Leaf 98 by 60, petiole 21 mm. Turbott, 1946 (AM).

## FAMILY THYMELEACEAE.

**Pimelea tomentosa (Forst.) Druce.**
Great Island. Cheeseman, 1887 (*P. prostrata*)—"on top of island in shade of tea tree." Cheeseman, 1889 (*P. prostrata* and *P. virgata*).

Fraser, 1928—"Where the slopes are broken with boulders *Pimelea prostrata* grows abundantly." Oliver, 1934 (DM). Baylis, 1945 (AM)—"Habit spreading, sometimes almost prostrate." Turbott, 1946 (AM)—"Close to saddle, eastern section of island. Small shrub, white flowers."

As all the specimens preserved in New Zealand museums belong to *P. tomentosa,* I am uniting all the records under this name. Prostrate examples of *P. tomentosa,* such as those collected by Baylis, could possibly be mistaken for *P. prostrata.*

## FAMILY MYRTACEAE.

**Leptospermum scoparium** Forst.
Great Island. Cheeseman, 1887. Baylis, 1945 (AM). South West Island. Cheeseman, 1889—above gannet colony.

**Leptospermum ericoides** A. Rich.
Great Island. Cheeseman, 1887. Fraser, 1928 (DM). Fraser states: "The island, particularly the higher portion, is clothed principally with white tea tree, *manuka rauriki* (*L. ericoides*), which, though much distorted by winds, attains a height of about 10 to 20 feet" (*N.Z. Jour. Sci. Tech.,* 11, 152, 1929). Oliver, 1934 (DM). Baylis, 1934, 1945 (AM). Turbott, 1946 (AM). South West Island. Cheeseman, 1889 (AM) (*L. sinclairii*). North East Island. Buddle, 1947. West Island. Buddle, 1947.

**Metrosideros excelsa** Gaertn.
Great Island. Cheeseman, 1887—"In one or two places near the edge of the cliffs some worn and stunted pohutukawas (*M. tomentosa*) can be found." Cheeseman, 1889—"On the cliffs. Pohutukawas are seen all round the island, but in small numbers, and are dwarfed and stunted compared with their usual size on the mainland." Fraser, 1928. Oliver and Baylis, 1934. Baylis, 1945 (AM). South West Island. Buddle, 1947. North East Island. Cheeseman, 1889. Buddle, 1947. West Island. Buddle, 1947.

**Metrosideros robusta** A. Cunn.
Three Kings Islands. Cheeseman, 1889.

**Metrosideros perforatum** (Forst.) Rich.
Great Island. Cheeseman, 1887 (*M. scandens*). Baylis, 1945 (AM).

## FAMILY ONAGRACEAE.

**Epilobium junceum** Forst. f.
Three Kings Islands. Cheeseman, 1889.

**Epilobium nummularifolium** A. Cunn.
Three Kings Islands. Cheeseman, 1889. Baylis, 1934 (AM).

## FAMILY HALORAGIDACEAE.

**Haloragis erecta** (Murr.) Schind.
Great Island. Cheeseman, 1887 (*H. alata*)—"on top of the island in shade of tea tree." Baylis, 1934, 1947, a few seedlings seen.

**Haloragis procumbens** Cheesem.

Great Island. Cheeseman, 1887 (*H. depressa*)—"on top of island in shade of tea tree." Cheeseman, 1889 (*H. tetragyna*). Baylis, 1934 (AM)—very rare under *manuka*. Baylis, 1945 (AM). Turbott, 1946 (AM).

In his *Manual of the New Zealand Flora*, 1925, Cheeseman lists from the Three Kings only *H. procumbens*, and as the Auckland Museum specimens belong to this species I conclude that Cheeseman's early records all refer to the same species. *H. procumbens* is doubtfully distinct from *H. incana*, which name precedes *procumbens*.

## FAMILY ARALIACEAE.

**Pseudopanax lessonii** (DC.) Goch.

Great Island. Cheeseman, 1889—"plentiful in the valley."

**Meryta sinclairii** (Hook. f.) Seem.

Great Island. Turbott and Bell, 1946—only one juvenile plant seen on an inaccessible cliff face. South West Island. Cheeseman, 1889 (AM)—"Nearly the whole of the northern side of the island, where not too steep, was covered with it. . . . The average height of the *puka* was from 10ft. or 15ft. to 20ft., but specimens almost 30ft. in height were noticed. At the time of our visit the female trees were ornamented with large bunches of purplish black berries." Buddle, 1947—"large grove several acres in extent. Trees range to 2ft. 6in. in diameter and up to 30ft. in height." North East Island. Cheeseman, 1889—"The whole of the top is covered with light bush mostly composed of *puka*." Buddle, 1947 (AM)—"grove 3-4 acres in extent on the top of the islet." West Island. Buddle, 1947.

## FAMILY UMBELLIFERAE.

**Hydrocotyle americana** L.

Great Island. Cheeseman, 1887 (*H. heteromera*). Baylis, 1945 (AM).

**Hydrocotyle novae-zealandiae** DC.

Great Island. Cheeseman, 1887. Baylis, 1934, 1945 (AM). Turbott, 1946 (AM).

**Centella asiatica** (L.) Urban.

Three Kings Islands. Cheeseman, 1889. Great Island. Oliver, 1934 (DM). Baylis, 1934, 1945 (AM). Turbott, 1946 (AM).

**Lilaeopsis novae-zealandiae** (Gandog.) Hill.

Great Island. Baylis, 1945 (AM)—Half submerged in Tasman Stream.

**Apium prostratum** Lab.

Great Island. Cheeseman, 1887 (*A. australe*)—by shore, north landing. Turbott and Bell, 1946 (AM)—top of cliffs, South-east Bay.

**Angelica rosaefolia** Hook.

Great Island. Cheeseman, 1887—North landing, near shore. Fraser, 1928 (DM)—"Where the slopes are broken with boulders the *kohepiro* grows abundantly." Baylis, 1945 (AM).

**Daucus glochidiata** (Lab.) Finsch.

Three Kings Islands. Cheeseman, 1889 (*D. brachiatus* Sieb) Great Island, Baylis, 1947.

## FAMILY CORNACEAE.

**Corokia cotoneaster** Raoul.

Great Island. Cheeseman, 1887.

## FAMILY ERICACEAE.

**Gaultheria antipoda** Forst. f.

Three Kings Islands. Cheeseman, 1889.

## FAMILY EPACRIDACEAE.

**Leucopogon fasciculatus** (Forst. f.) A. Rich.

Three Kings Islands. Cheeseman, 1889. Great Island, Baylis, 1947.

**Leucopogon fraseri** A. Cunn.

Great Island. Cheeseman, 1887—on top of island in shelter of tea tree. Baylis, 1947.

## FAMILY MYRSINACEAE.

**Suttonia australis** A. Rich.

Great Island. Turbott and M. Chaney, 1946 (AM)—Tasman Valley, stream bed. One tree near tree ferns, 12ft.

**Suttonia dentata** Oliver, n. sp.

A small glabrous tree with stiff widely diverging branchlets covered with dark brown bark, the ends smooth, green. Leaves alternate, elliptic or obovate, bluntly acute or with the tip rounded or even slightly emarginate, sometimes folded at the tip, irregularly dentate along the upper half; coriaceous, rather thick, with thickened margin, reticulated on both surfaces, thickly dotted with pellucid, often reddish, oil glands; petiole short, stout. Average leaf 69 mm. long, 32 broad, petiole 10; shade leaf 93 mm. long, 40 broad, petiole 7. Young leaves with scabrid surface and very short bristles. Flowers in dense clusters on the branchlets between the leaves at a little distance from the ends. Pedicels $2\frac{1}{2}$ mm. long, slender. Calyx deeply 5-fid, lobes narrow. Petals 5, free, elliptic, acute, longer than the stamens, with minute bristles on the margin, studded with oil glands. Stamens 5, opposite the petals. Ovary with capitate stigma. Fruit depressed-globose, flat topped, 5 mm. long, 7 diam.

Type specimen in Auckland Museum, collected by G. T. S. Baylis on Great Island, Three Kings Islands, December 4th, 1945.

Arbor glabra. Folia alterna, elliptica vel obovata, acuta vel obtusa, dentata ad apice, coriacea. Flores fasciculi. Calyx 5-fidus, lobis acutis. Petala 5, libera, elliptica, acuta, marginibus ciliatis. Stamina petalis opposita. Ovarium stigma capitata. Fructus depresso-globosus.

A *S. chathamica* differt ramulis glabris, foliis dentatis acutis, sepalis angustatis.

Baylis describes this species as follows: "A small tree, 10 to 20ft. high. Bark smooth, greyish. Trunk slender. Crown rounded, fairly dense."

*S. dentata* is related nearest to *S. chathamica,* but differs in its glabrous branchlets, acute, dentate leaves, narrow sepals, elliptic petals, and stamens shorter than the petals.

Great Island. "Three widely separated specimens were found in the Tasman Stream valley. None bore any flowers or fruit. Two more trees, one bearing remains of male flowers, were found on a steep scree on the northern coast about 800 fet above the sea. The foliage is somewhat different from the trees in the valley, but so is the habitat. I located two further trees which appeared to be the same near Hapuka Point but could not reach them" (Baylis). Oliver, Baylis and Turbott, 1934 (AM, DM). Baylis, 1945 (AM). Turbott, 1946 (AM)—rocky slope below Hapuka Point. Turbott, Bell and B. Chaney, 1946 (AM)—northern cliff face.

## FAMILY SAPOTACEAE.

**Sideroxylon novo-zelandicum** (F. Muell.) Hemsl.

Great Island. Turbott, 1934 (AM)—Eastern section of island, scarce. Baylis, 1945 (AM). Turbott and Bell, 1946 (AM).

## FAMILY OLEACEAE.

**Olea apetala** Vahl.

Great Island. Oliver, 1934 (DM)—small leaves, up to 92 by 40 mm. Turbott and Bell, 1946 (AM)—In group of trees, northern cliff face, with large-leafed tree [*Plectomirtha*]; also seaward slopes south of Crater Head.

## FAMILY LOGANIACEAE.

**Geniostoma ligustrifolium** A. Cunn., var. **major** Cheesem.

Great Island. Cheeseman, 1889 (AM)—"An unusually large-leaved variety of the *hangehange* is common." Oliver, 1934 (DM)—leaf, 90 by 49, petiole, 14 mm. Baylis, 1945 (AM). Turbott and Bell, 1946 (AM)—Tasman Valley, by streams.

## FAMILY APOCYNACEAE.

**Parsonsia heterophylla** A. Cunn.

Great Island. Baylis, 1945 (AM). Turbott and Bell, 1946 (AM)—northern cliff face. Leaf, 88 by 57, petiole, 20 mm. South West Island. Cheeseman, 1889 (*P. albiflora*). North East Island. Buddle, 1947.

## FAMILY CONVOLVULACEAE.

**Ipomoea palmata** Forst.
North East Island. Buddle, 1947 (AM)

**Calystegia sepium** (L.) R. Br.
Great Island. Cheeseman, 1887.

**Calystegia tuguriorum** (Forst. f.) R. Br.
Great Island. Cheeseman, 1887.

**Dichondra repens** Forst.
Great Island. Cheeseman, 1887. Oliver, 1934 (DM). Baylis, 1945 (AM). Turbott, 1946 (AM). North East Island. Buddle, 1947.

## FAMILY BORAGINACEAE.

**Myosotis spathulata** Forst. f.
Great Island. Cheeseman, 1887. Cheeseman, 1889 (AM).

## FAMILY VERBENACEAE.

**Vitex lucens** T. Kirk.
Great Island. Baylis, 1945 (AM). Turbott and Bell, 1946 (AM) —valley above depot.

## FAMILY SOLANACEAE.

**Solanum nigrum** L.
Three Kings Islands. Cheeseman, 1889. Great Island. Turbott and Bell, 1946 (AM)—above cliff, South-east Bay. North East Island. Buddle, 1947.

**Solanum aviculare** Forst. f.
Three Kings Islands. Cheeseman, 1889. Great Island. Baylis, 1947.

## FAMILY SCROPHULARIACEAE.

**Hebe insularis** (Cheesem.) Ckne. & Allan.
*Veronica insularis* Cheesem. *Trans. N.Z. Inst.*, 29, 392, 1897. Three Kings Is., type specimen in Auckland Museum; *Man. N.Z. Flora*, 510, 1906 *id.* Ed. 2, 797, 1925. *Hebe insularis* (Cheesem.) Ckne. & Allan, *Trans. N.Z. Inst.*, 57, 25, 1927. Great Island. Cheeseman, 1889 (*Veronica sp.*). Fraser, 1928 (DM)—"On the cliff at Tasman Falls and overhanging the pool immediately above the falls was found a pale lavender-blue *koromiko*, a showy and beautiful plant growing to a height of about two feet." Oliver, 1934 (DM). Baylis, 1945 (AM)—"flowers pale blue." South West Island. Cheeseman, 1889 (AM, DM). Buddle, 1947 (AM)—plentiful on the islet.

Cheeseman states that this species is closely allied to *H. elliptica*. The leaves agree closely, but the inflorescenc in *H. insularis* is branched, whereas in *H. elliptica* it is a simple raceme.

## FAMILY BIGNONIACEAE.

**Tecomanthe speciosa** Oliver, n.sp.

A tall woody climber. Leaves imparipinnate, common petiole stout. Terminal leaflet and upper pair adjacent, lower pair near middle of common petiole. Terminal leaflet obovate, base slightly unequal-sided, cuneate, apex rounded, emarginate, unequal-sided; midrib stout, ribbed; lateral veins strong, 6-7 on either side of midrib, reticulation obscure. Upper end lower pairs of leaflets very unequal-sided at base, the outer side being rounded and joining the petiolule near its base, the inner side cuneate, joining the midrib about 10 mm. from the base. Apex slightly emarginate, slightly unequal-sided; venation as in terminal leaflet.

Measurements of leaf:

| Common petiole to lower leaflets. | Common petiole to upper leaflets. | Terminal leaflet. | Petiolule | Upper pair. | Petiolule. | Lower pair. | Petiolule. |
|---|---|---|---|---|---|---|---|
| 94 | 162 | 147 x 102 | 30 | 135 x 85 | 2 | 103 x 75 | 5 |
| 75 | 137 | 135 x 87 | 30 | 133 x 82 | 2 | 98 x 68 | 2 |

Inflorescence corymbose, axillary few flowered. "The flowers are well down on the older stems, not on young shoots" (Turbott). Flowers on corymb. Calyx cup-shaped, with 4, sometimes 3 or 5, acute or obtuse lobes. In opened flowers the calyx splits to the base. Outside with a velvety surface. margin thickened and smooth. Length 18-19 mm., Pedicels 10 mm. Corolla gradually widening from base, tube, 37 mm., nearly half as long as flower, 77 mm. "creamy-white, sometimes greenish" (Turbott), buff yellow when dry. Lobes with rounded sides, acute, inner surface smooth, outer densely covered with woolly hairs (2 short petals); on the three longer petals the woolly portion on the back is divided into an outer dense part with concave margin and an inner less dense and differently coloured part. Inside the tube at the point where the stamens become free from it are patches of long jointed hairs. The longer petals are joined far beyond the top of the tube.

Stamens 4, filaments arising at base of corolla tube and joined thereto for about 10-12 mm. Stamens 60-70 mm. long in same flower. Anthers 9 mm. long, lobes diverging. Staminodium filiform, about 25 mm. long, sparingly hairy. Pistil about 60 mm. long, with 2 truncate stigmatic lobes.

Type specimen in Auckland Museum, collected by E. G. Turbott on Great Island, Three Kings Group, May 12th, 1946.

Caulis scandens, ligneus. Folia imparipinnata, paribus duobus. Foliolum terminale obovatum, base inaequilaterale, cuneatum, apice rotundatum, emarginatum, nervo medio costato, robusto, nervis lateralibus robustis, 6-7 utrobique. Foliola laterales base multo inaequilaterales, apice nonnihil emarginates. Inflorescentia corymbosa, axillaris. Calyx cupuliformis, 3-4 lobis, obtusis. Corolla base non contracta, intra pilosa; tubus lobis aequalis; lobi 5, inaequalis, intra glabra, extra lanata. Stamina 4, ad basem corollae conjuncta. Staminodium filiforme, sparce pilosum, pistillum stigma bilobato. Fructus ignotus.

*C. hillii* affinis sed foliis multo major, late obovatis, corollae tubo non contracto, staminodio longo.

From Dr. Baylis' notes I take the following information: "Liane. A vigorous twiner ascending to the top of a large tree of *Leptospermum ericoides,* i.e., about 25-30 feet. Rooted in swampy soil in the bed of one of the tributaries of the Tasman Stream. Old stems rooting freely where they sprawled across wet ground." Regarding the flowers, Turbott notes: "Creamy-white, sometimes greenish, green sepals. Orange-yellow anthers. Several bunches flowers fully opened; also buds about to open."

A small specimen of this species was forwarded to the Kew Herbarium and a reply was received from the Director enclosing a report from Mr. N. Y. Sandwith containing the following remarks: "Mr. Oliver's material, as would be expected, resembles *Tecomanthe hillii* much more closely than any other species, and is strongly suggestive of it in certain characters. It is probable, however, that it represents a new endemic species." I have not seen a specimen of *Tecomanthe hillii,* but from a description and figure I gather that *T. speciosa* differs in the following characters: the leaflets are obovate instead of ovate-lanceolate and are much larger; the calyx is rather thick, not membranous; the corolla is not rosy-purplish; the staminodium is longer.

Great Island. "In the bed of one of the tributaries of the Tasman Stream about one mile from the sea and 500ft. above sea level. Only one specimen on the island. All suitable habitats are accessible and were examined" (Baylis). Baylis, 1945 (AM). Turbott, 1946 (AM). North East Island. Buddle, 1947, several plants seen on top of islet.

## FAMILY MYOPORACEAE.

**Myoporum laetum** Forst. f.

Great Island. Fraser, 1928 (DM)—"Where the slopes are broken with boulders the *ngaio* grows abundantly." Oliver, 1934 (DM)—Coastal rocks. Some leaves elliptic, long, acute, 118 by 40, petiole. 10 mm.; others short and broad, 97 by 45, petiole, 18 mm. with fine serrations and produced apex. Baylis, 1945 (AM)—prostrate form with short, broad, sharply toothed leaves. Turbott, 1946 (AM). South West Island. Cheeseman, 1889. Buddle, 1947. North East Island. Buddle, 1947.

## FAMILY PLANTAGINACEAE.

**Plantago raoulii** DC.

Great Island. Oliver, 1934 (DM). Baylis, 1945 (AM).

## FAMILY RUBIACEAE.

**Coprosma rhamnoides** A. Cunn.

Great Island. Fraser, 1928 (DM)—"Where the slopes are broken with boulders *C. rhamnoides* grows abundantly." Oliver, 1934 (DM)—undergrowth in *kanuka* forest; densely divaricating shrub. Baylis, 1945 (AM). Turbott, 1946 (AM).

*Plectomirtha baylisiana*, Great Island. Specimen in Auckland Museum, collected by G. T. S. Baylis, 2nd December, 1945.

Photo, B. W. Hall.

**Coprosma robusta** Raoul.
Great Island. Cheeseman, 1887.

**Coprosma macrocarpa** Cheesem.
*Coprosma macrocarpa* Cheesem. *Trans. N.Z. Inst.*, 20 1471, 1888. Great Island, type specimen in Auckland Museum; *Man. N.Z. Flora*, 246, 1906; *id.* Ed. 2, 858, 1925. Kirk, *Stud. Fl., N.Z.*, 230, 1899. Oliver, *Bull.* 132, *Bish. Mus.*, 112, 1935.

Great Island. Cheeseman, 1887 (AM). Cheeseman, 1889 (AM, DM)—plentiful. Oliver, 1934 (DM)—leaf, 132 by 75, petiole, 20 mm. Baylis, 1934, 1945 (AM)—Leaf, 140 by 66, petiole, 20 mm. (1945). South West Island. Cheeseman, 1889. Buddle, 1947 (AM). North East Island. Buddle, 1947 (AM).

**Coprosma australis** (A. Rich.) Robinson.
Great Island. Cheeseman, 1887. Fraser, 1928—"In sheltered localities facing eastward."

**Coprosma repens** A. Rich.
Great Island. Cheeseman, 1887 (*C. baueriana*)—north landing. Fraser, 1928 (DM)—"Where the slopes are broken with boulders the *angiangi* (*C. baueri*) grows abundantly." Baylis, 1945 (AM). Turbott and Bell, 1946 (AM)—By pool above Tasman Falls. Princes Islets. Buddle, 1947 (AM). North East Island. Buddle, 1947.

## FAMILY CUCURBITACEAE.

**Sicyos angulata** L.
Great Island. Cheeseman, 1887—"north landing, near shore. Scrambling among the rocks were large masses of *Sicyos angulatus*." Turbott and Bell, 1946 (AM)—Growing over kanuka, top of cliff. Baylis, 1947. South West Island. Cheeseman, 1889. North East Island. Buddle, 1947.

## FAMILY CAMPANULACEAE.

**Colensoa physaloides** (A. Cunn.) Hook. f.
Great Island. Cheeseman, 1887 (AM)—"Along the margin of the little stream which occupies the bottom of the gully were large masses of the rare *C. physaloides*." Cheeseman, 1889—"In open, sunny places were large masses of *C. physaloides*." Oliver, 1934 (DM). Baylis, 1934 (AM)—"not relished by goats." Baylis, 1945 (AM). Turbott and Bell, 1946 (AM)—Tasman Stream bed. New shoot on old stump left by goats, 4th May.

**Lobelia anceps** L.
Great Island. Cheeseman, 1887—north landing, near shore. Oliver, 1934 (DM). Baylis, 1945 (AM). Turbott and Bell, 1946 (AM)—South-east Bay, above cliff.

**Wahlenbergia gracilis** (Forst. f.) Schrad.
Great Island. Cheeseman, 1887. Fraser, 1928 (DM)—on the cliff at Tasman Falls. Baylis, 1945 (AM). Turbott, 1946 (AM). South West Island. Buddle, 1947 (AM). North East Island. Buddle, 1947.

## FAMILY COMPOSITAE.

**Lagenophora pumila (Forst. f.) Cheesem.**

Great Island. Cheeseman, 1887—on top of island in shade of tea tree. Oliver, 1934 (DM). Baylis, 1945 (AM).

**Gnaphalium luteoalbum L.**

Three Kings Islands. Cheeseman, 1889. Great Island. Baylis, 1945 (AM).

**Gnaphalium japonicum Thunb.**

Great Island. Cheeseman, 1887 (*G. involucratum*)—on top of island in shade of tea tree.

**Gnaphalium collinum Lab.**

Great Island. Cheeseman, 1887. Oliver, 1934 (DM). Baylis, 1945 (AM). Turbott, 1946 (AM)—under kanuka.

**Siegesbeckia orientalis L.**

Great Island. Baylis, 1934, 1947 (AM).

**Bidens pilosa L.**

Three Kings Islands. Cheeseman, 1889.

**Cotula australis (Lieb.) Hook. f.**

Great Island. Oliver, 1934 (DM). Baylis, 1945 (AM).

**Centipeda orbicularis Lour.**

Great Island. Oliver, 1934 (DM). Baylis, 1945 (AM).

**Erectites arguta (A. Rich.) DC.**

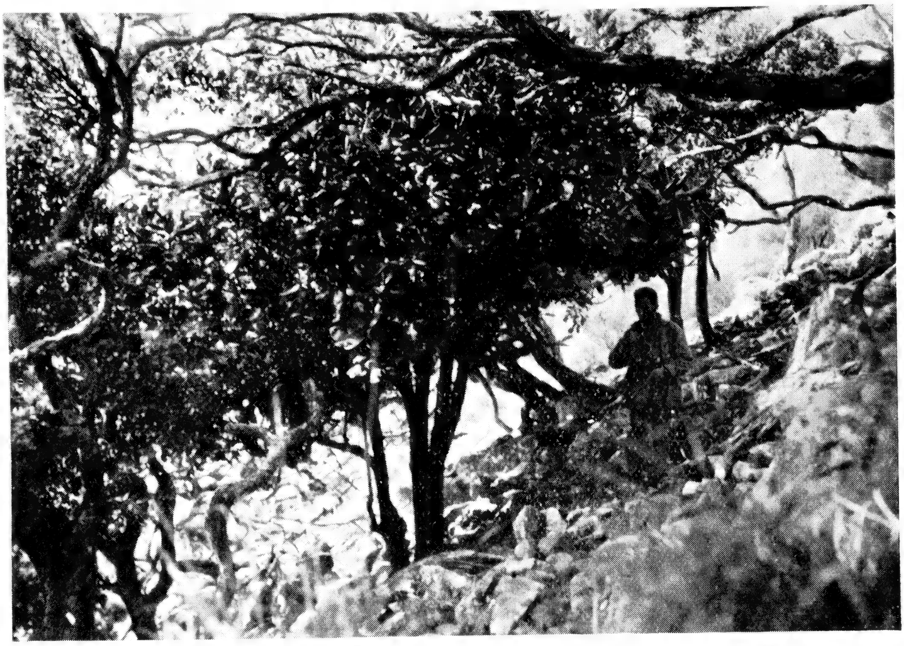
Three Kings Islands. Cheeseman, 1889

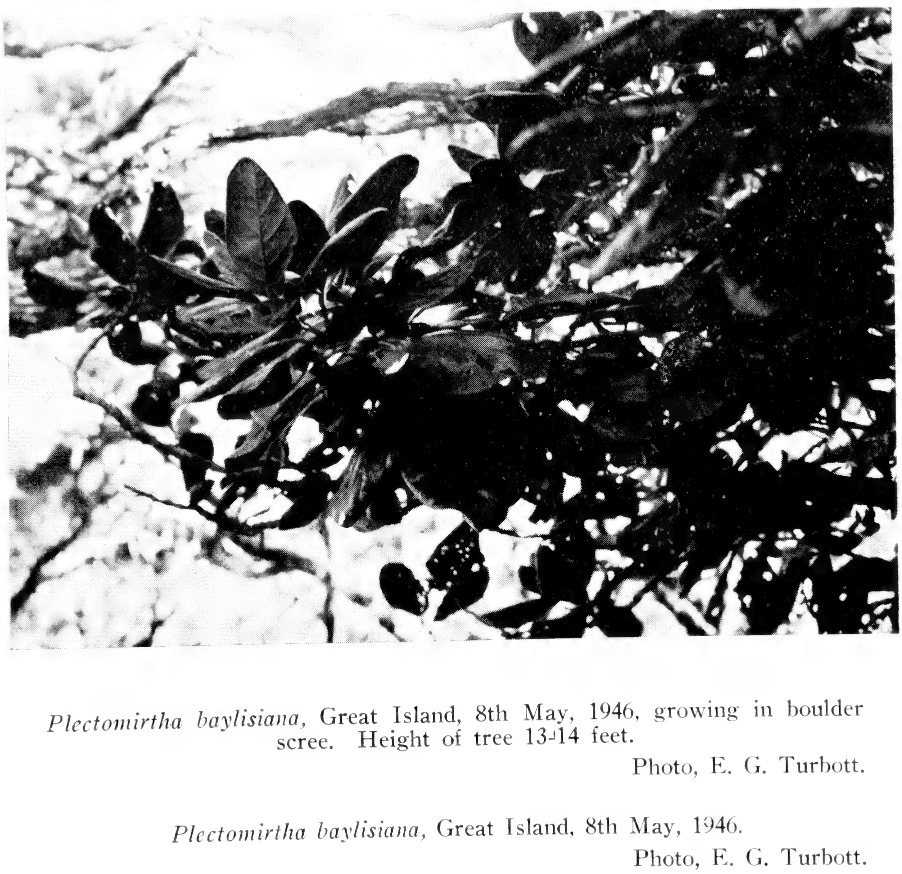
**Erechtites quadridentata (Lab.) DC.**

Three Kings Islands. Cheeseman, 1889.

**Brachyglottis arborescens Oliver n. sp.**

A small tree, 3 to 6 m. in height, with a stout trunk up to 30 cm. in diameter. Bark thick, grey, longitudinally ridged. A dense woolly tomentum covers the ends of the branchlets, young leaves on both sides, petioles and under surface of the adult leaves, and branches of the panicle; it is white or whitish, but is tinged with brown on young leaves, petioles and nerves of adult leaves. Leaves broadly obovate, widest above the middle, from there curving to a nearly right angled apex, and narrowing towards the base, which in the smaller leaves is truncate and in the larger ones cordate; rather thin, glossy, margin sinuate, the upper half with projecting lobes which, in the largest leaves, are more developed. Nerves prominent on both surfaces. Average upper leaf, 130 long, 80 diam., petiole, 30 mm.; largest shade leaf, 220 mm. long, 165 wide, petiole 75. Panicle single on each branchlet, in the axil of a subterminal leaf, shorter than the leaves, about 120 mm. long and the same in diameter; flowers numerous, 5 mm. long, the involucral bracts elliptic, blunt, margin ciliate at the tip, membranous, the central band brown (dried specimen) the marginal bands whitish. Achene ribbed. Pappus a single row of long, white, weak hairs with short branches, inserted on the expanded top of the achene. Florets about 12, of which more than half are male.





*Plectomirtha baylisiana,* Great Island, 8th May, 1946, growing in boulder scree. Height of tree 13-14 feet.

Photo, E. G. Turbott.

*Plectomirtha baylisiana,* Great Island, 8th May, 1946.

Photo, E. G. Turbott.

Type specimen in Auckland Museum, collected by G. T. S. Baylis on Great Island, Three Kings Islands, December 1st, 1945.

Arbor, 3-6 m. alta, trunco robusto. Cortex crassus, corrugatus. Ramuli, folia juveniles, petioli, folia adulta infra, inflorescentia, dense tomentosi. Folia obovata, ad basem truncata vel cordata, margine sinuata, paulum lobata, nitida. Panicula axillaris, foliis brevior, floribis numerous. Involucri bracteae ellipticae, obtusae, margine ciliatae. Achenium costatum. Pappus longus, albus.

A *B. repanda* differt trunco arborescente, foliis paulum lobatis, cordatis, panicula breve.

The following information is supplied by Dr. G. T. S. Baylis: "A small tree, 10 to 20ft. in height. Trunk stout, may exceed 1 foot in diameter at the base. Primary branches few, ascending, commonly arising at a low level. In old trees the trunk is often hollow. Bark very thick, grey, in corky ridges ½ to 1 inch wide, ¼ to ½in. deep. Crown dense, rather flat. Leaves fairly dark green above and very glossy. Lamina curling backwards in strong light."

This species is distinguished from *B. repanda* and from the doubtful species *B. rangiora* by the following characters: arborescent habit with stout trunk; rough bark; leaves with less prominent lobes and narrowing lower half with cordate base; panicle shorter than the leaves; involucral bracts longer.

Great Island. "There are two groves each containing about a dozen of these trees mixed with *kanuka*. Both are on steep greywacke screes facing the sea, one about 350ft. above sea level below and to the south of the depot above South-east Bay, the other 700ft. above sea level on the seaward slopes south of Crater Head; also a few isolated trees near these groves" (Baylis). Baylis, 1945 (AM). Turbott, 1946 (AM).

**Senecio lautus Forst. f.**

Great Island. Cheeseman, 1887—near shore, north landing. Fraser, 1928—on the cliffs at Tasman Falls. Baylis, 1945 (AM). South West Island. Cheeseman, 1889—Edges of cliffs on either side of gannet colony. North East Island. Buddle, 1947.

**Sonchus oleraceus L.**

Great Island. Cheeseman, 1887. Turbott and Meachen, 1946 (AM). Baylis, 1947.

## INTRODUCED SPECIES.

*Polypogon monspeliensis* Desv. Great Island. Baylis, 1948.

*Vulpia dertonensis* (All.) Volk. Great Island. Baylis, 1945 (AM).

*Bromus mollis* L. Great Island. Baylis, 1945 (AM).

*Aira caryophyllaea* L. Great Island. Oliver, 1934 (DM). Baylis, 1945 (AM).

*Aira praecox* L. Great Island. Baylis, 1945 (AM). Turbott, 1946 (AM).

*Cerastium caespitosum* Gilib. Great Island. Baylis, 1945 (AM).

*Gnaphalium purpureum* L. Great Island. Baylis, 1948.

*Cirsium lanceolatum* (L.) Hill. Great Island. Baylis, 1945 (AM). Turbott and Meachen, 1946 (AM).

*Hypochaeris radicata* L. Great Island. Oliver and Baylis, 1934 (AM, DM). Baylis, 1947.

*Taraxicum officinale* Weber. Great Island. Baylis, 1945 (AM). Turbott, 1946 (AM).

Besides the above named species there are three which I have included in the indigenous list but which possibly have been introduced to New Zealand and consequently should be regarded as introduced to the Three Kings Islands, namely: *Solanium nigrum, Cotula australis* and *Sonchus oleraceus.*

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## LITERATURE ON FLORA OF THREE KINGS ISLANDS.

CHEESEMAN, T. F., 1888. Notes on the Three Kings Islands. *Trans. N.Z. Inst.*, 20, 141-150.

CHEESEMAN, T. F., 1891. Further Notes on the Three Kings Islands. *Trans. N.Z. Inst.*, 23, 408-424.

CHEESEMAN, T. F., 1892. On some Recent Additions to the New Zealand Flora. *Trans. N.Z. Inst.*, 24, 409-412. (*Alectryon excelsum* var. *grandis.*)

CHEESEMAN, T. F., 1897. On some Plants new to the New Zealand Flora. *Trans. N.Z. Inst., 29, 390-393.* (*Veronica insularis.*)

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CHEESEMAN, T. F., 1925. *Manual of the New Zealand Flora.* Ed. 2.

FRASER, W. M., 1929. Notes on a Visit to Three Kings Islands. *N.Z. Jour. Sci. Tech.*, 11, 148-156.

OLIVER, W. R. B., 1935. The Genus Coprosma. *Bull. Bishop Mus.*, 132.

*Tecomanthe speciosa*, Great Island, 12th May, 1946.
Photo, E. G. Turbott.

*Suttonia dentata*, Great Island. Specimen in Auckland Museum, collected by G. T. S. Baylis, 1st December, 1945.
Photo, B. W. Hall.

# Vegetation of Great Island, Three Kings Group

By G. T. S. BAYLIS,

Botany Department, University of Otago, Dunedin.

In May, 1946, the Department of Internal Affairs, in answer to representations made by Mr. A. W. B. Powell, then Acting Director of the Auckland Museum, sent a party of deer-stalkers to Great Island to destroy the goats whose presence threatened with extinction many of the plants and animals peculiar to the locality. This commendable action brought to an end a long period of modification of the plant cover by man and by stock liberated upon the island. As Great Island is now uninhabited and rarely visited, it should remain free from further interference and undergo changes of considerable interest ecologically. The purpose of this paper is to trace briefly the past history of the vegetation, and to record its condition immediately prior to removal of the goats. Unfortunately, owing to the difficulties of access it is based on but limited study—two half-days ashore in February, 1934, and a week in November, 1945. For both these opportunities I am indebted to officers of the Auckland Museum. I have in addition received special assistance from Mr. E. G. Turbott, who placed at my disposal much information and many photographs obtained during the visit of the goat-shooting party. Mr. Turbott took advantage of his fairly long stay on the island to establish permanent quadrats. These are described in an accompanying paper, and their existence will enable future development of the plant cover to be traced with greater accuracy than would be possible on the basis of this account alone.

## HISTORY OF ALIEN FACTORS AFFECTING THE VEGETATION.

Maoris were living on Great Island at the time of its discovery by Tasman in 1643 (Tasman, 1898). His men did not land, but saw cultivated plots in the Tasman Valley and between thirty and thirty-five persons. The island was still inhabited in 1772 and was at this date described by Crozet as grassy with groves of bushes (Roth, 1891). About twenty years later yet another passing mariner saw signs of occupation (Labillardière, 1799), and it is significant that in 1810 a trading party at the Bay of Islands, apprehensive of trouble with the natives, contemplated taking refuge in the group because they believed goats and hogs to be available there for food (McNab, 1908). Other evidence of the presence of goats about this time is cited by Cheeseman (1887)* who records an instance of goat skins being obtained from Great Island.

* Cheeseman's statement that the "Betsey" survivors lived on the Three Kings is not supported by McNab's (1914) account of their adventures.

Maori occupation ended about 1840 (Cheeseman, 1887). It thus lasted at least intermittently for two centuries or longer, and the inhabitants kept goats and probably pigs in the latter years. Moreover, as a place of refuge from threat of massacre in tribal wars, the island was probably often overpopulated and its resources utilised to the utmost. This appears to have been the case at the time of Puckey's visit in 1835 (Puckey, 1836). It is reputed at one time to have supported about a hundred persons (Cheeseman, 1887).

After departure of the Maoris occasional visitors burnt patches of the island. Areas that appear thus affected are the predominantly grassy land south-west of the Tasman Stream, the vicinity of the castaway depot, and the eastern tip of the island. According to contemporary press accounts the second of these was fired in 1902 by survivors of the "Elingamite."

The main factor modifying the vegetation in the present century has, however, been the goats. These were not, it seems, survivors of the Maori settlers' livestock, which was apparently too highly prized to be left behind on their departure.* This is indicated by the abundance of highly palatable plants (e.g., *Angelica rosaefolia*† and large-leaved *Coprosma* species) when the island was first described botanically—by Cheeseman, who landed in 1887 and again in 1889. It is confirmed by the fact that in order that there might be food for possible castaways it was deemed necessary to restock the island with goats at this time, and four of these animals were landed from the Government steamer on the occasion of Cheeseman's second visit.‡ Cheeseman must have been aware of this, but apparently did not then appreciate the damage goats could do to the native vegetation so saw no reason to record their arrival. Further evidence of this attitude is provided by this author's (1887a) account of the vegetation of Macauley I. The grassy nature of the plant cover appears to have surprised him, yet he makes no mention of the herd of goats on which that peculiarity depends (Oliver, 1909).

These four goats appear to have multiplied with great rapidity. A member of the "Elingamite" salvage party* states that these animals were plentiful by 1903, Fraser (1909) estimated their number at 300 in 1928, and in 1934 the island seemed to the present author to have been supporting about a maximum population. The number destroyed in 1946 was 393.

## THE PRIMITIVE FOREST.

Even at the time of Cheeseman's visits the forest of Great Island was therefore far from primitive. The best guides to its original composition are the vegetation of other islands of the group and the few groves of mixed trees which occur on Great Island itself. In connection

* This conclusion may be incorrect—see appendix.

† Major R. Wilson informs me that in his experience this is the first species to disappear where goats enter new country.

‡ In am indebted to the Secretary of Marine for furnishing this information from departmental records. Two goats were also landed on S.W. Island (called Western King by the Marine Department), but these apparently failed to establish themselves (Buddle, 1947).

* Mr. D. G. Mathew, of Auckland.

*Brachyglottis arborescens.* Great Island. Photo. G. T. S. Baylis.

*Brachyglottis arborescens,* Great Island. Specimen in Auckland Museum, collected by G. T. S. Baylis, 1st December, 1945. Photo. B. W. Hall.

with the former it is necessary to consider the extent to which they also may have been modified. Despite difficulty of access and lack of permanent water there is evidence of Maori occupation of these islets (Buddle, 1948). Nevertheless, all of them large enough to support trees (North-East, South-West, and West* Islands) bear a type of forest wholly different from that of Great Island and one in which endemic and semi-endemic species are prominent. It seems safe to assume that this is virtually a primitive community, interference by the Maori having in the absence of goats been quite transitory in its effects—and probably far less than that to which the comparatively hospitable Great Island was subject.

My own study of the forest on the smaller islands has been limited to what little can be accomplished from a boat offshore, and the following description depends largely on the observations made by Cheeseman (1890) and by Buddle (1947). The dominant tree is for the most par the puka (*Meryta sinclairii*), which tends to form pure stands. On both the West and North-East Islands, however, its place is taken over small areas by the pohutukawa (*Metrosideros excelsa*). The chief subdominant is the large-leaved kawakawa (*Macropiper excelsum* var. *major*). *Cordyline australis, Paratrophis smithii, Coprosma macrocarpa* and *Melicope ternata* probably rank in this category also. The principal forest floor herbs are the ferns *Asplenium lucidum* and *Pteris comans*.

As all members of the group are similar geologically, this type of forest presumably occupied on the main island stations similar to that in which it still occurs on the smaller ones. These are the steep faces between about 200 and 600 feet above the sea which have some covering of soil. The community may have grown further inland, for it has no opportunity of demonstrating its capacity for this on the small islands.* The evidence afforded by relics of the primitive vegetation persisting on Great Island itself suggests that this was not the case, but rather that wherever there wa smore shelter than the small islands afford and a fair depth of soil, Great Island carried a mixed coastal or semi-coastal forest with the same dominant species as may be found on the mainland and other coastal islands (Cockayne, 1928; Cranwell & Moore, 1935; Oliver, 1925). These included *Metrosideros excelsa, Litsaea calicaris, Hedycarya arborea, Vitex lucens, Sideroxylon novozelandicum, Corynocarpus laevigata, Olea apetala* and *Melicytus ramiflorus*. Distinction would be given to the community, however, by the large liane *Tecomanthe speciosa* growing along the streams and by the smaller trees, since in this category the island presents several species which are locally endemic, namely, *Paratrophis Smithii, Suttonia dentata, Brachyglottis arborescens, Coprosma macrocarpa,* Pittosporum Fairchildii, Alec-*

* Cheeseman (1890) describes West Is. as "little more than a bare rock." This is its northern aspect, but from the south-east *Phormium* is visible in some quantity and also both pohutukawa and puka.

* It is noteworthy that in the Hen and Chickens Islands, the only other locality in which *Meryta Sinclairii* is indigenous, it is a member of mixed coastal forest wherein it forms occasional consociations all of which are near the sea (Cranwell and Moore, 1935).

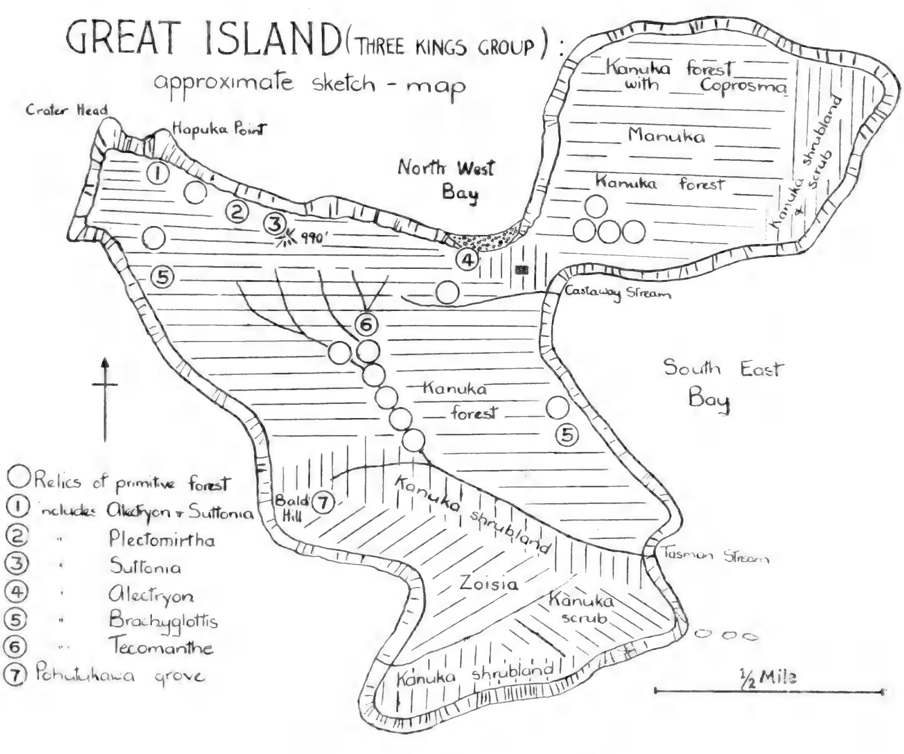
* Oliver (1935) considers that this species includes forms found outside the Three Kings Group. However, the large fruit of the Three Kings plant is perhaps distinctive.

*tryon grandis* and *Plectomirtha baylisiana.* The extent to which these grew with the larger trees as sub-dominants is uncertain, however. Of the two that survive in some numbers one (*Paratrophis*) suggests by its distribution and shade tolerance that it did so, the other (*Brachyglottis*) that it did not, pointing rather to the existence of a third type of forest in windswept and stony places above the *Meryta* belt. In this these small trees would have been dominant, accompanied no doubt by non-endemic species, notably *Hiemerliodendron* (*Pisonia*) *brunoniana, Melicope ternata* and *Cordyline australis.*

Only one specimen of *Meryta* has ever been found on Great Island. According to Messrs. Turbott and Bell, by whom it was discovered in May, 1946, the tree was little more than a seedling and rooted on an inaccessible cliff ledge. The principal species accompanying it on other islands, *Macropiper excelsum,* does, however, figure in Cheeseman's list of 1887; Since *Meryta* is a very thin-barked tree and its family, the *Araliaceae,* is highly palatable (Aston, 1911), its virtual absence now does not invalidate the arguments in favour of its having been plentiful.

## THE PRESENT VEGETATION.

The most striking feature of Great Island today is the uniform appearance of the plant cover. *Leptospermum ericoides,* the kanuka, is the sole dominant in nearly all situations. This species appears to be




Vegetation of Great Island in 1945.

Fig. 1. View south from head of Tasman Valley. Tasman Bay (left), South Point (centre) and Bald Hill (right).

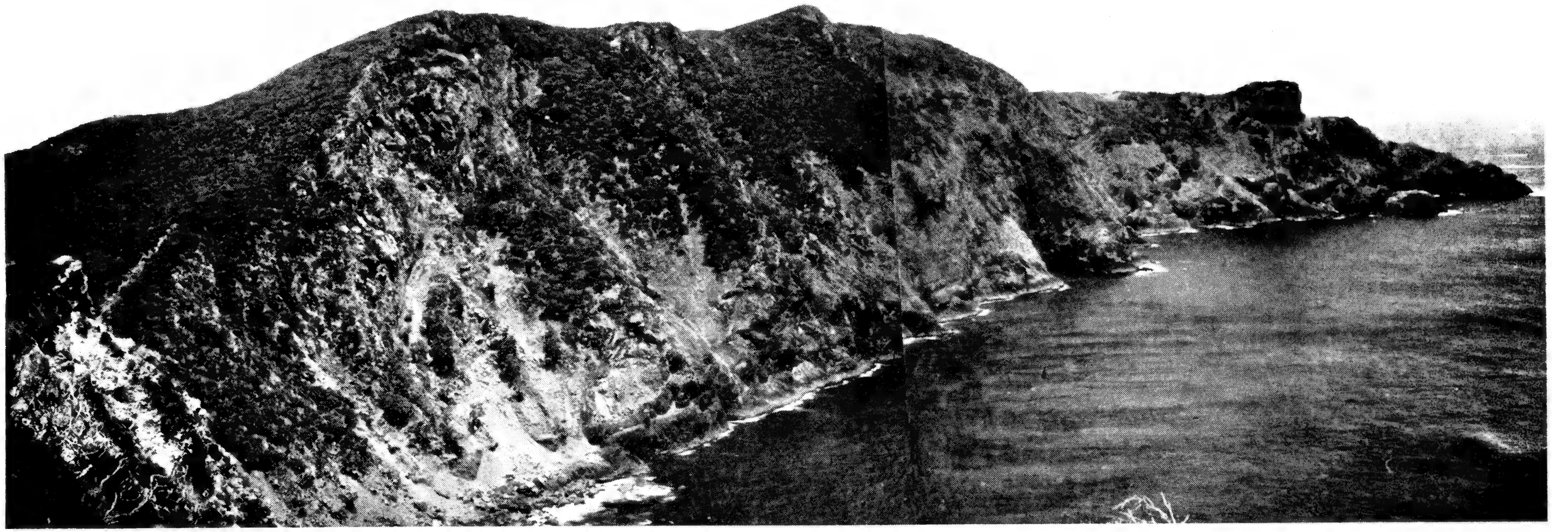


Fig. 2. Northern coastline from the head of N.W. Bay (left) to Crater Head.

characteristic of old Maori clearings on the coastal islands of North Auckland (Oliver, 1925; Cranwell & Moore, 1935; Hamilton, 1936). On Great Island it shows much plasticity of growth form, on the basis of which it is convenient to subdivide the kanuka communities into forest, shrubland and prostrate scrub, but between these types there is no sharp distinction.

**(1) Kanuka Forest (Figs. 6, 8, 9).**

What is commonly called "tall tea-tree" is the principal plant association, best developed in the valleys but extending even on to the stony soil of very steep faces which form the upper part of many of the cliffs. The only species with any claim to be considered co-dominant are the cabbage tree (*Cordyline australis*) and manuka (*Leptospermum scoparium*), but specimens of both are so far between that they are of no moment except about the centre of the eastern limb of the island where manuka occurs in almost pure stands over a small area. This manuka appears to be undergoing replacement by kanuka (Fig. 8), and in this connection it should be noted that Cheeseman (1897) gives the impression that *L. scoparium* was the principal species at the time of his visits. This could be true of areas like that round the present castaway depot which have been burnt and have regrown since, but judging by the manifest age o fthe kanuka in the Tasman Valley the ambiguous term "tea-tree" in Cheeseman's accounts must often mean *L. ericoides*, a species which he certainly collected.

The kanuka is slender and rarely above twenty feet in height except in parts of the Tasman Valley where it shows some approach to the size it has attained in old Maori clearings on Taranga Island (Cranwell and Moore, 1935). Epiphytes are lacking and lianes rare. Only two shrubs, *Coprosma rhamnoides* and *Myoporum lactum*, occur as subdominants and both of these have a limited distribution, the former being plentiful only beneath wide-spaced senescent trees on the eastern limb of the island (Fig. 9), and the latter occasionally forming a straggling under-scrub within a few yards of the clifftops.

Apart from occasional specimens of wharangi (*Melicope ternata*) which seem to resist destruction for a time (Turbott, 1948), there are no seedlings of woody plants on the forest floor. Where the canopy is dense, raw humus formed from twigs and leaves of kanuka accumulates and supports little but *Dichondra repens*. Usually the roof is less close and *Carex testacea* forms conspicuous tussocks except on rich damp soil where *C. virgata* replaces it. *Scirpus nodosus*, a plant truly ubiquitous on the island, is also plentiful. Between these larger species is a more or less continuous turf in which most of the small grasses and herbs listed at the end of this article are found.

Kanuka forest is undoubtedly a sub-climax, its persistence depending on elimination of seedlings of the climax trees by goats. As the climax species are now very rare it must have been many years since their seedlings had any tendency to appear in quantity. Young plants of kanuka like the adult are unpalatable, but since they are intolerant of shade they appear only after death of the old trees. *Carex testacea* and other species of the floor are not deleteriously affected by loss of shade,

however, and their persistence in glades which are opening up in old kanuka about the head of the Tasman Valley is delaying re-establishment of that forest. Patches dominated by this sedge recall on a small scale dominance by the grass *Macrolaena avenacea,* which has been induced by stock on Te Moehau (Moore and Cranwell, 1934). In much of the eastern limb of the island the kanuka is dying when only about ten feet high. There is little humus and *Carex testacea* is uncommon. The ground is left bare apart from a sparse growth of *Scirpus nodosus,* a few windshorn bushes of young kanuka and mosses* (Fig. 10).

**(2) Kanuka Shrubland.**

In places the kanuka is too low in stature to be termed forest and must be regarded as shrubland. Excluding small patches on very shallow soil these areas are clearly only a stage of growth of the forest on land comparatively recently burnt, i.e., near the castaway depot, on the southern side of the lower Tasman Valley, and near the eastern tip of the island. Except for the fact that *Carex testacea* does not seem to establish itself until there has been some accumulation of humus, the accompanying species are much as in the forest.

The growth rate is appreciable. In 1934 the shrubland about the castaway depot was not above four feet tall, so that the building, which is some eight feet in height, was a conspicuous landmark. Eleven years later it was completely hidden from most angles (Figs. 4 and 5).

**(3) Kanuka prostrate scrub.**

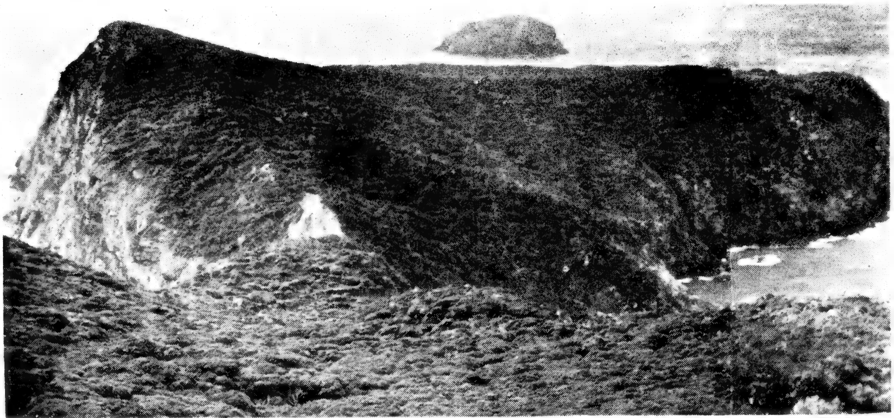
There are, however, areas in which the kanuka is so modified in habit that there is little indication that it will ever attain the tree form. The plants are low mats spreading close to the ground, their branches save for the leafy tips buried in silt and humus. Adventitious roots occasionally appear. In many cases mats several feet across are nowhere more than three inches in height; others may rise to about a foot at the centre. This low habit is universal over the windswept face south of the mouth of the Tasman Stream. A closely grazed turf of *Zoisia matrella* occupies the intervening spaces, and *Scirpus nodosus* grows through and between the mats (Fig. 11).

**(4) Zoisia sward.**

Much of the land south of the Tasman Stream is covered by a sward of *Zoisia matrella* through which creeps a sparse growth of *Centella asiatica.* Scattered upon it are pieces of charred wood, but as there are no stumps the association destroyed by fire must at most have been but shrubby (Fig. 12). The date of burning is difficult to fix. At the time of Cheeseman's (1890) visits this slope was grassy.* It seems likely that in the intervening period kanuka established itself on the area and was in due course fired. It is now extending slowly upwards again from the valley bottom, gaining a foothold mainly in colonies of *Scirpus nodosus* with which the sward is dotted, but sometimes independently.

* The principal species has in the absence of fruit been provisionally determined as *Campylopus bicolor* (Hornsch.) Hook by Mr. G. O. K. Sainsbury. Others are *C. introflexus* (Hedw.) Mitt., *Leptodontium interruptum* (Mitt.) Broth. and *Debera nutans,* Hedw.

* Cheeseman did not examine this area closely, which is sufficient explanation of the absence of *Zoisia* from his lists.



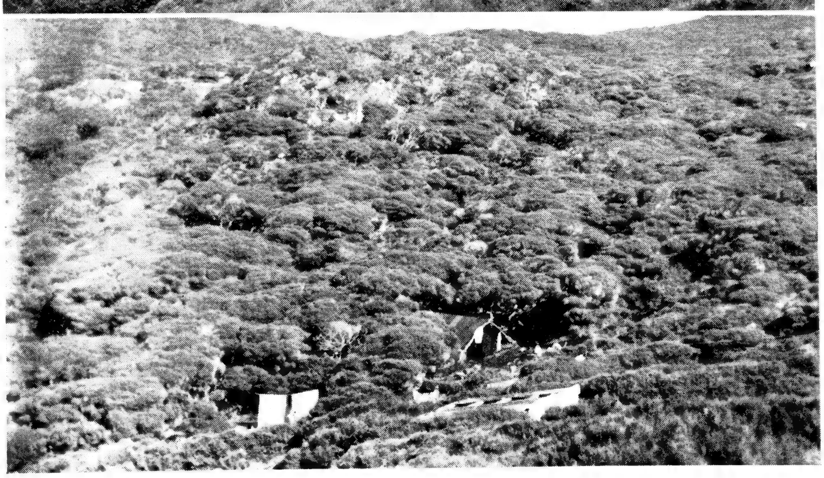


Fig. 3. View of the eastern limb of Great Island from the head of Castaway Valley, North East Island in distance. (E. G. Turbott.)

Figs. 4 and 5. The depot and Castaway Valley from the same point in 1934 and in 1946. (E. G. Turbott.)

*Zoisia* was probably the pioneer inhabitant of the area when it was left bare after fire. Its ability in this respect is well shown on Bald Hill,† where there is at present about half an acre of bare soil much eroded by wind and rain. It seems to have arisen following death of pohutukawa forest, of which a remnant still remains immediately adjacent—a favourite camping place for goats and entirely devoid of undergrowth. *Scirpus nodosus* and *Cladium junceum* are extending slowly on to the bare area from its margins, the former accompanied as a rule by *Zoisia*, the latter growing alone. Of these colonisers the grass only is sufficiently aggressive to establish itself in the midst of the eroded land. Here it builds up hummocks resembling those formed by sandbinders on a dune (Fig. 13).

Oliver (1909) records on Macauley Island a comparable instance of a sward-forming grass displacing a woody plant (*Myoporum laetum*) after burning and in the presence of goats. In this case the grass is an exotic (*Polypogon monspeliensis*). Neither *Zoisia* nor *Leptospermum* are represented in the Kermadec flora.

**(5) Cliff Vegetation.**

Fissures and ledges on the sea-cliffs which are inaccessible to goats support species no longer found elsewhere. Commonest are the rock lily (*Arthropodium cirrhatum*), *Cyperus ustulatus*, and the endemic *Hebe insularis*, but a good many others, indicated by (i) in the list at the end of this article, still have a foothold here. Elsewhere, destruction of these species has left much bare rock and increased the accumulation of scree material, especially at the head of North-West Bay. The only plant at present taking advantage of the extension of this type of habitat is the ngaio (*Myoporum laetum*). The low, sprawling form common on coastal islands of North Auckland (Cockayne, 1928; Cranwell and Moore, 1935; Oliver, 1935) has occupied some of the screes above the landing place in North-West Bay and on the eastern side of Hapuka Pt.

**(6) Remnants of Original Forest.**

Destruction of most of the original forest can undoubtedly be ascribed to Maori settlers, who under force of circumstances cleared and cultivated surprisingly inhospitable places. So it was that even when Cheeseman landed the vegetation was predominantly kanuka. The most conspicuous relic of climax forest that survives is a small grove of pohutukawa below Bald Hill, apparently the remains of a consociation of that species. The pohutukawa is widely scattered over cliffs and steep faces elsewhere, but only as single meagre specimens or small groups. This grove is the only instance of trees other than *Leptospermum* occupying land capable of cultivation. Other relics of the old forest are confined to the banks of the Tasman Stream (Fig. 7), and patches of very rocky ground elsewhere—places which either escaped clearing or were permitted to begin regeneration sufficiently early for the process not to have been arrested by the depredations of the goats. Along the Tasman Stream these remnants form a very broken chain of small groves. Of those more isolated, the clump of twelve trees in Castaway Valley affords a good example illustrating well the character-

† Cheeseman's (1890) "Knoll covered with pohutukawa trees."

istic diversity of species which contrasts strongly with the monotony of the surrounding kanuka. In this case there is a puriri (*Vitex lucens*), a mangeao (*Litsaea calicaris*), a wharangi (*Melicope ternata*), three small trees each of mahoe (*Melicytus ramiflorus*) and cabbage-tree (*Cordyline australis*), two of milk-tree (*Paratrophis Smithii*) and one of pigeonwood (*Hedycarya arborea*). It is on the flora of such fragments that the list of species presumed to have dominated the original mixed coastal forest is based. One cannot, of course, be satisfied that they are fully representative.

## CHANGES SINCE 1889.

When Cheeseman made his brief examinations of Great Island in 1887 and 1889, the vegetation was much less monotonous than it is today. For fifty years it had been undisturbed* by alien factors and among the predominating *Leptospermum* constituents of a mixed coastal forest seem to have been re-appearing, but were as yet of small size ("the tea-tree . . . is mixed with shrubs or small trees, but there is nothing approaching the dimensions of an ordinary forest tree"). † Of woody species now so rare that protracted search of the whole island can locate not more than a half-dozen specimens the following were noted by Cheeseman at least more than once during his hurried visits, most of them being actually termed plentiful—*Coprosma macrocarpa, Corynocarpus laevigata, Geniostoma ligustrifolium, Hedycarya arborea, Hiemerliodendron* (*Pisonia*) *brunoniana, Pittosporum Fairchildii, Pseudopanax Lessonii.* This regenerating forest was eaten out by the goats landed in 1889. They also virtually if not entirely destroyed *Colensoa physaloides* and the forest-floor ferns except *Doodia media.* Plants other than trees then plentiful on hillsides and now absent save perhaps in inaccessible places were *Phormium tenax, Arundo kakaho. Pteridium esculentum*‡ and *Leucopogon Fraseri.* The present barrenness of the cliffs above the landing place appears to be due principally to the destruction of *Sicyos angulata, Angelica rosaefolia, Phormium tenax, Arundo kakaho, Disphyma* (*Mesembryanthemum*) *australe* and *Apium prostratum*, all of which no longer occupy this particular station.

In an accompanying paper Oliver (1948) records all the vascular plants that have at any time been noted or collected in the Three Kings Islands. The list at the end of this article shows the state of the flora in 1945-1946. A comparison reveals that 25 species which had been recorded from Great Island itself some time between 1887 and 1934 could no longer be located in the year prior to the removal of the goats. They are: *Acianthus fornicatus* R. Br., var. *Sinclairii* (Hook. f.) Hatch; *Calystegia sepium* (L.) R. Br.; *C. tugariorum* (Forst. f.) R. Br.; *Cladium teretifolium* R. Br.; *Clematis parviflora* A. Cunn.; *Coprosma robusta* Raoul.; *C. australis* (A. Rich.) Robinson; *Cyclosorus pennigera* (Forst. f.) Copel.; *Deyeuxia filiformis* (Forst. f.) Hook, f.; *Entelea arborescens* R. Br.; *Epilobium nummularifolium* A. Cunn.; *Gnaphalium japonicum* Thunb.; *Haloragis erecta* (Murr.) Schind.; *Hypolepis tenui-*

* Perhaps not wholly so—see appendix.

† (1887) p. 143.

‡ Still seen occasionally on the eastern limb of the island.

Fig. 6. Interior of kanuka forest, Tasman Valley.

Fig. 7. Grove of mixed trees beside Tasman Stream: *Melicytus ramiflorus*, *Cordyline australis*, *Leptospermum ericoides*, *Paratrophis smithii*, *Cyathea medullaris*.

*folia* (Forst. f.) Bernh.; *Leucopogon Fraseri* A. Cunn.; *Lycopodium volubile* Forst. f.; *Myosotis spathulata* Forst. f.; *Polystichum Richardi* (Hook f.) Sm.; *Pseudopanax Lessonii* (D.C.) Koch.; *Pteris tremula* R. Br.; *Siegesbeckia orientalis* L.; *Tillaea sieberiana* Schultz; *Unicinia unciniata* (L.) Kirk. If one accepts appearance in the list given in Cheeseman's second paper, unaccompanied by any indication as to whether the record relates to Great Island or to South-West Island, as being in effect a record for Great Island (as is likely in the majority of cases), then this list would be extended by the addition of a further 27 names. Moreover, it should be borne in mind that approximately half of the species admitted in the present paper as still being present on the island are reduced to a very few specimens or restricted to places inaccessible to goats.

In view of the brevity of Cheeseman's surveys it is impossible to be sure whether or not there has since been some addition to the flora to compensate for this loss. *Zoisia matrella* is not in Cheeseman's lists, but this seems likely to be a mere omission—the fact that the island was divided 56 years ago between *Leptospermum* and grass areas much as it is today suggests that no ecologically significant species has established itself in the interval.

## LIST OF VASCULAR PLANT GROWING ON GREAT ISLAND, 1945-1946.

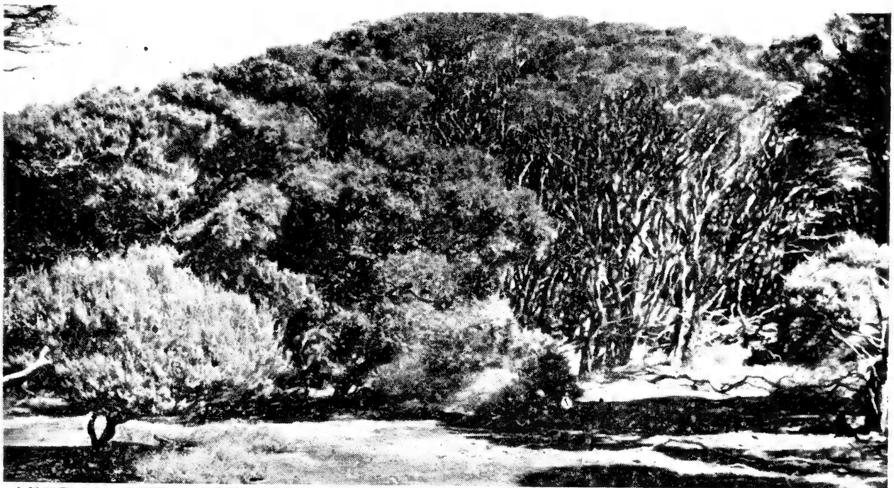
The following list is based mainly on my collection made in November, 1945, but a few records depend on specimens obtained in May, 1946, by the goat-shooting party and forwarded to me by Mr. E. G. Turbott.

I am indebted to Dr. H. H. Allan for examining members of difficult genera and to Miss B. Molesworth for assistance in referring to the Cheeseman herbarium. Dr. W. R. B. Oliver kindly placed his determinations of all available Three Kings herbarium material at my disposal prior to publication, and the names adopted in the following list conform with his opinions. The material on which the list is based is lodged in the Auckland Museum.

Of the 118 species named, 21 (i) can be found only in places inaccessible to goats, 40 (r) are rare (in most cases the number of individual plants known to exist is given), 31 (o) are found only occasionally, so that maintenance of plant cover really depends on the remaining 26, which are common (c) or abundant (a). It is remarkable, in view of the long period over which the vegetation has been modified by exotic agencies, that only four of these twenty-six plants are definitely not indigenous in the New Zealand region, and the ecological significance of these is limited by the fact that they are all small annual herbs (*Aira praecox*, *A. caryophyllea*, *Cotula australis* and *Vulpia dertonensis*). Species which are members of New Zealand's naturalised flora are distinguished in the following list by an asterisk.

*Adiantum affine* Willd. (r)
*Adiantum hispidulum* Swartz. (o)
* *Aira praecox* L. (a)
* *Aira caryophyllea* L. (a)
*Alectryon grandis* Cheesem. (r-2)

*Angelica rosaefolia* Hook. (i)
*Apium prostratum* Lab. (i)
*Arundo kakaho* Steudel (i)
*Arthropodium cirrhatum* (Forst. f.) R. Br. (i)
*Asplenium obtusatum* Forst. (i)
*Asplenium flaccidum* Forst. (i)
*Brachyglottis arborescens* Oliver. (r-35)
* *Bromus mollis* L. (o)
*Blechnum procerum* (Forst. f.) Anders. (i)
*Blechnum norfolkianum* (Hew.) C. Chr. (r)
*Caladenia carnea* R. Br. var. *minor* (Hook. f.) Hatch (o)
*Callitriche Muelleri* Sond. (r)
*Cardamine heterophylla* (Forst. f.) Schulz. (r)
*Carex breviculmis* R. Br. (c)
*Carex testacea* Boott. (a)
*Carex lucida* Boott. (o)
*Carex virgata* Hook. f. (c)
*Carex Forsteri* Wahl. (r)
*Centipeda orbicularis* Lour. (o)
*Centella asiatica* (L.) Urban (a)
* *Cerastium caespitosum* Gilib. (r)
* *Cirsium lanceolatum* (L.) Hill (o)
*Cladium junceum* R. Br. (o)
*Cladium rubiginosum* (Forst. f.) Druce (o)
*Clematis indivisa* Willd. (r-4)
*Colensoa physaloides* (A. Cunn.) Hook f. (r)
*Coprosma macrocarpa* Cheesem. (r-4)
*Coprosma repens* A. Rich. (i)
*Coprosma rhamnoides* A. Cunn. (o)
*Corynocarpus laevigata* Forst. (r-7)
*Cordyline australis* (Forst. f.) Hook. f. (c)
* *Cotula australis* (Lieb.) Hook. f. (c)
*Cyathea medullaris* Swartz. (r)
*Cyperus ustulatus* A. Rich. (i)
*Danthonia semiannularis* R. Br. (c)
*Davallia Tasmani* Cheesem. (i)
*Deyeuxia crinita* (L.) Zotov. (c)
*Dianella intermedia* Endl. (r)
*Dichondra repens* Forst. (a)
*Disphyma australe* (Forst. f.) Black. (i)
*Doodia media* R. Br. (c)
*Echinopogon ovatus* (Forst. f.) Beauv. (c)
*Eleocharis acuta* R. Br. (r)
*Geniostoma ligustrifolium* A. Cunn. (r-2)
*Geranium dissectum* L. var. *glabratum* Hook. f. (r)
*Gnaphalium collinum* Lab. (c)
*Gnaphalium luteo-album* Linn. (r)
*Haloragis procumbens* Cheesem. (c)
*Hebe insularis* (Cheesem.) Ckn. (i)
*Hedycarya arborea* Forst. (r-5)
*Hiemerliodendron brunoniana* (Endl.) Skottsb. (r-5)
*Hydrocotyle americana* Linn. (r)
*Hydrocotyle novaezealandiae* D. C.. (c)
*Hymenanthera novaezealandiae* (A. Cunn.) Hemsl. (i)
*Juncus vaginatus* R. Br. (r)
*Lagenophora pumila* (Forst. f.) Cheesem. (c)
*Leptospermum ericoides* A. Rich. (a)
*Leptospermum scoparium* Forst. (o)
*Lilaeopsis novaezealandiae* (Gandog.) Hill. (r)
*Litsaea calicaris* (A. Cunn.) Hook. f. (r)
*Lobelia anceps* Linn. (o)
*Macropiper excelsum* (Forst. f.) Miq. var. *major* Cheesem. (i-1)
*Melicytus ramiflorus* Forst. (o)
*Melicope ternata* Forst. (o)



Three photographs from the eastern limb of Great Island.

Fig. 8. Kanuka (left) apparently replacing over-mature manuka (right). (E. G. Turbott.)

Fig. 9. *Coprosma rhamnoides* growing beneath over-mature kanuka.

Fig. 10. Kanuka re-establishing itself in open glades formed by death of old specimens.

*Meryta Sinclairii* (Hook. f.) Seem. (i-1)
*Metrosideros excelsa* Gaertn. (o)
*Metrosideros perforata* (Forst.) Rich. (i)
*Microsorium diversifolium* (Willd.) Copel. (r)
*Microtis unifolia* (Forst. f.) Reich. (c)
*Muehlenbeckia complexa* (A. Cunn.) Meissn. (o)
*Myoporum laetum* Forst. (o)
*Olea apetala* Vahl. (r-3)
*Oplismenus undulatifolius* Beauv. (c)
*Oxalis corniculata* Linn. (c)
*Paratrophis Smithii* Cheesem. (o)
*Parietaria debilis* Forst. (r)
*Parsonsia heterophylla* A. Cunn. (o)
*Peperomia Urvilleana* A. Rich. (i)
*Phormium* sp. (i)
*Pimelia tomentosa* (Forst.) Druce. (o)
*Pittosporum Fairchildii* Cheesem. (r-4)
*Plantago Raoulii* D.C. (o)
*Plectomirtha baylisiana* Oliver (r-1)
*Poa anceps* Forst. (i)
*Poa seticulmis* Petrie (o)
*Pteridium esculentum* (Forst. f.) Ckn. (o)
*Pteris comans* Forst. (o)
*Pyrrosia serpens* (Forst. f.) Ching. (o)
*Ranunculus hirtus* Forst. f. (c)
*Rhagodia nutans* R. Br. (r)
*Salicornia australis* Forst. f.) (i)
*Schizaea fistulosa* Labill. (o)
*Schoenus foliatus* (Hook. f.) Blake (o)
*Scirpus cernuus* Vahl. (o)
*Scirpus inundatus* (R. Br.) Poir. (o)
*Scirpus nodosus* Rottm. (a)
*Senecio lautus* Forst. (o)
*Sicyos angulata* Linn. (r-1)
*Sideroxylon novozelandicum* (F. Muell.) Hemsl. (r-4)
*Solanum nigrum* L. (r)
* *Sonchus oleraceus* L. (r)
*Spergularia marginata* Kittel. (r)
*Suttonia australis* A. Rich. (r-1)
*Suttonia dentata* Oliver. (r-7)
* *Taraxacum officinale* Weber. (r)
*Tecomanthe speciosa* Oliver. (r-1)
*Tetrapathaea tetrandra* (D.C.) Cheesem. (o)
*Tetragonia trigyna* Hook. f. (i)
*Thelymitra longifolia* Forst. (o)
*Vitex lucens* T. Kirk. (r-2)
* *Vulpia dertonensis* (All.) Volk. (c)
*Wahlenbergia gracilis* (Forst. f. ) Schrad. (a)
*Zoisia matrella* (Linn.) Merrill. (a)

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## APPENDIX: GREAT ISLAND IN DECEMBER, 1947.

Through the kindness of Major M. E. Johnson, of the Yacht "Rosemary," I was able to spend in all about eighteen hours on Great Island at the end of December, 1947. It was possible to examine only part of the island in that time, but a collection was made which included:—

(a) Ten species not previously recorded from Great Island, namely: *Agropyron Kirkii* Zotov, *Cheilanthes Sieberi* Kunze, *Chenopodium triandrum* Forst. f, *Chloris truncata* R. Br., *Lepidium oleraceum* Forst. f., *Microlaena stipoides* R. Br., *Pelargonium inodorum* Willd., *Physalis peruviana* L., *Polypogon monspeliensis* (L.) Desf., *Pterostylis trullifolia* Hook. f.

(b) Eight species recorded by earlier collectors (Oliver, 1948) but no longer apparent in 1945, namely: *Daucus glochidiata* (Lab.) Oliver, *Deyeuxia billardieri* Kunth., *Hypochoeris radicata* Lab., *Leucopogon fasciculatus* (Forst. f.) A. Rich, *L. Fraseri* A. Cunn., *Pteris tremula* R. Br., *Siegesbeckia orintalis* L., *Solanum aviculare* Forst. f.

It does not follow that the species listed above had very recently established or re-established themselves on the island. They could easily have escaped earlier observation if confined to inaccessible places or were very closely browsed. The most interesting phytogeographically is *Chloris truncata*, which formed several well-grown patches in the *Zoisia* area. It is an Australian grass, and if it is regarded as indigenous on the Three Kings it becomes an addition to the Australian element of our flora which is generally considered to have been carried here by the prevailing westerly winds (Oliver, 1935, Cockayne, 1928). As there would be little place for grasses in the primitive vegetation of the Group it seems more

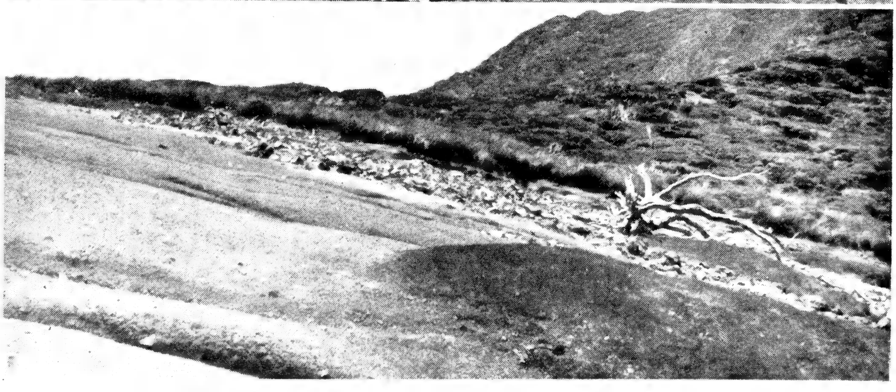

Fig. 11. Kanuka prostrate scrub on the hillside south of Tasman Bay. Tussocks are *Scirpus nodosus.*

Fig. 12. *Zoisia* sward with tussocks of *Scirpus nodosus.*

Fig. 13. *Zoisia matrella* colonising bare ground on Bald Hill. The area is fringed with *Scirpus nodosus.*

likely, however, that it has become naturalised since the vegetation was disturbed. It is still necessary to invoke wind dispersal from Australia as the means of entry, since human intervention in the introduction of the seed, which is usually applicable to naturalised species (Allan, 1937), seems exceedingly doubtful in this case. The New Zealand mainland would be a necessary stage in seed transport by man, and here *C. truncata* is known only as a rarely grown ornamental (I am indebted to Dr. H. H. Allan and Mr. E. A. Madden for information on this point). We are probably provided therefore with an example of that renewal of natural plant immigration which Setchell (1935) considers likely to occur where man-made changes affect a climax vegetation. A study of the list of Australian species naturalised in North Auckland would probably reveal others.

Despite the short period that had elapsed since the goats were destroyed, changes were already apparent in the vegetation. Coastal herbs were colonising the areas of bare eroded soil, the largest, Bald Hill, being sparsely dotted with plants of the following (in order of frequency):—

*Disphyma australis, Chenopodium triandrum, Gnaphalium luteo-album, Cyperus ustulatus, Polypogon monspeliensis, Sonchus oleraceus, Senecio lautus.*

There had been no active spread of *Zoisia matrella*, previously the only plant growing on this area. The same species were present on the cliff screes at North West Bay, but *Sonchus oleraceus* was more plentiful and there was also much *Solanum nigrum* and fairly numerous small seedlings of *Myoporum laetum*. A few vines of *Sicyos angulata*, plentiful here at the time of Cheeseman's visit, had already reappeared.

Much of the *Zoisia* sward, despite its close texture, was abundantly studded with seedlings of kanuka (*Leptospermum ericoides*) as yet only a few inches in height, and the open moss-covered places among the kanuka in the drier parts of the island (Fig. 10) were also being colonised by *Leptospermum* seedlings. These, however, were often predominantly manuka (*L. scoparium*), notwithstanding the comparative scarcity of mature trees of that species. This observation is interesting in view of the evidence discussed earlier of past changes in the relative abundance of manuka and kanuka.

The sedges, which had been dominant on the floor of the kanuka forest where this is reasonably moist and well lit, were being overtopped in places by grasses (principally *Danthonia semiannularis, Deyeuxia crinita, Oplismenus undulatifolius* and *Echinopogon ovatus*) or by *Colensoa physaloides*, a tall soft herb that was already forming quite extensive patches. Small plants of *Arthropodium cirrhatum* were also often seen. Most significant, however, was the presence of well-grown seedlings of *Meryta sinclairii, Cordyline australis* and *Brachyglottis arborescens*, all of which were repeatedly observed in the valleys east of the Depot, in Castaway Valley itself, and occasionally in the lower Tasman Valley (unfortunately very little of the Tasman Valley system was explored). Less frequently seedlings were seen of the following:—

*Litsaea calicaris, Hiemerliodendron brunoniana, Melicope ternata, Melicytus ramiflorus, Coprosma macrocarpa, Entelea arborescens, Pittosporum fairchildii, Geniostoma ligustrifolium, Tetrapathaea tetrandra, Clematis indivisa.*

The fact that *Meryta sinclairii* had established itself in quantity but nineteen months after removal of the goats calls for some comment. Since the species had not previously been recorded on Great Island (apart from the seedling seen in 1946) the seed must have come from adjacent islands. Major G. A. Buddle informs me that when he landed on South West Island he observed large numbers of red-billed gulls feeding greedily on the fruits of this tree. These are therefore likely to have been the chief agents of dispersal, the distance to be covered being only about a mile. The difficulty now is to account for the failure of *Meryta* to appear on Great Island in the interval between the departure of the Maoris and Cheeseman's visit if that was a period of unimpeded regeneration, as the evidence I have presented in the body of this paper suggests. I incline now to the view that the Maoris did in fact leave sufficient goats behind to prevent the re-establishment of *Meryta* by their selective browsing, but that they were not at first sufficient to prevent regeneration entirely.

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## SUMMARY.

1. It is considered that before Maori settlement Great Island was covered by *Meryta* forest close to the sea, and by mixed coastal forest elsewhere. The latter would be dominated in more favourable situations by species common in coastal forests on the North Auckland mainland and its adjacent islands, but small locally-endemic trees, of which seven species are known, were probably among the dominants on stony soils and in exposed situations. Some were no doubt present also in taller forest as subdominants.

2. This vegetation was almost wholly destroyed by Maori settlers.

3. With the departure of the Maoris about 1840 forest regeneration began. It may have been impeded by a small goat population, since *Meryta* had not reappeared by 1889.

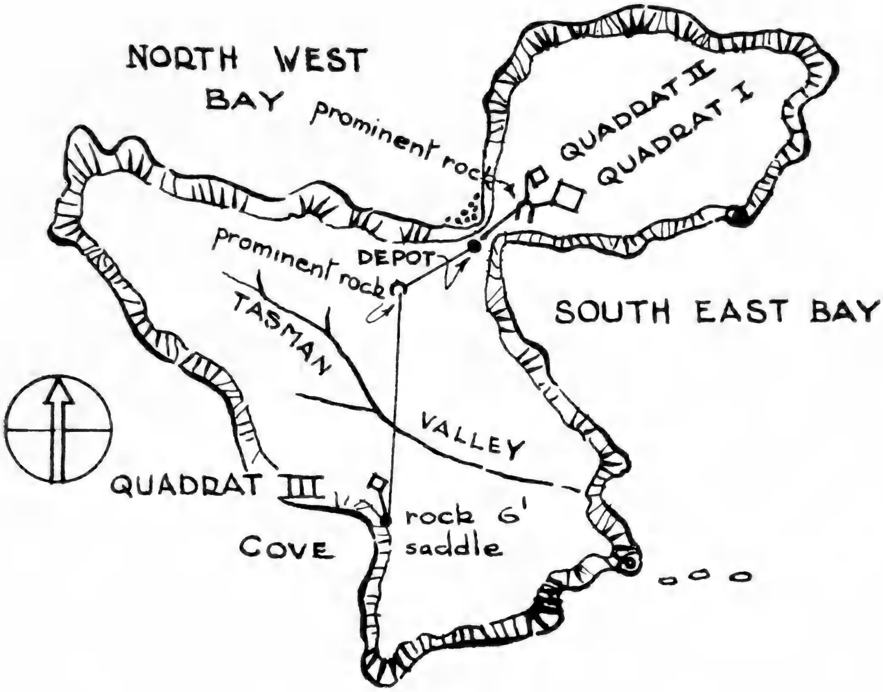
4. In 1889 four goats were landed. Subsequently goats became so numerous that the succession was soon halted, in most places at a subclimax stage dominated by *Leptospermum ericoides*. However, part of the island was still in grassland dominated by *Zoisia matrella* in 1945. This area probably suffered the added disturbance of a fire early in the present century.

5. In 1946 all goats were destroyed, and by the end of 1947 seedlings of the climax dominants were already in evidence. These included *Meryta*, which must have been carried by birds from other islands of the Group.

Two photographs taken at the end of December, 1947.

14. Floor of kanuka forest in a gully near the head of South-east Bay. The large leaved plants comprise a seedling of *Meryta* (centre foreground), *Colensoa* and *Pteris comans*.

15. Seedlings of *Brachyglottis arborescens* beneath mature trees. The creeping herb is *Chenopodium triandrum*.



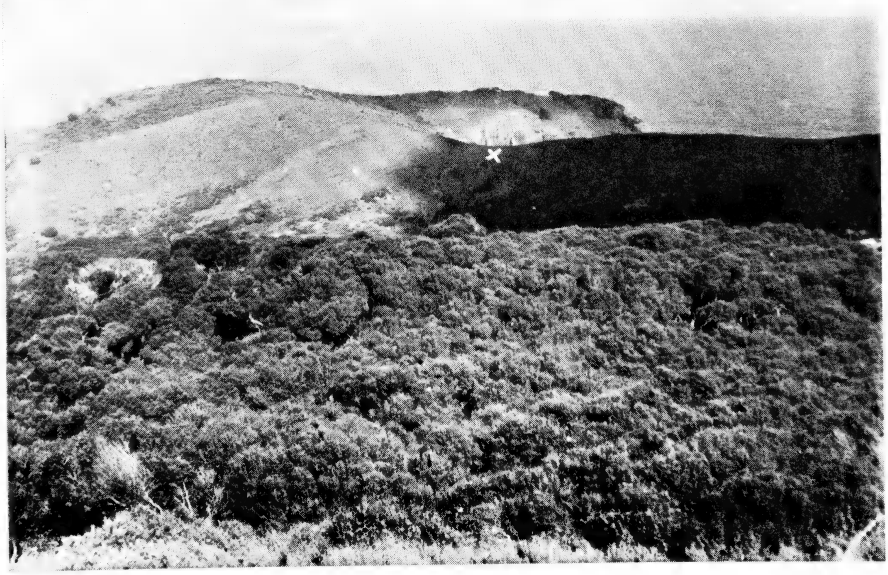



Fig. 1. Great Island, showing position of quadrats (not to scale).

Fig. 2. Tasman Valley from prominent rock to south-west of depot. Quadrat III is situated under cloud shadow approximately 95 yards from the lowest point (X) of the saddle above the south-western cove.

# Effect of Goats on Great Island, Three Kings, with descriptions of Vegetation Quadrats.

By E. G. TURBOTT, M.Sc., Auckland Museum.

Goats, the most evidently destructive of man's animal satellites, have become naturalised on numerous islands of small or moderate area throughout the world. Their marked effect within the compass of such islands first became familiar through the dramatic accounts of Darwin (1839) and later of Wallace (1880), who describes the denuding of a "luxuriant forest vegetation" on St. Helena. In the Pacific this process, due partly or wholly to goats, has been repeated to varying degrees on a number of islands, for example on the Marquesas (Adamson, 1939); and has occurred in the New Zealand area on members of the Kermadec (Oliver, 1910), Auckland and Three Kings groups.

The effect of goats on the New Zealand mainland has been described by Thomson (1922), Moore and Cranwell (1934), Zotov *et al* (1939) and Wodzicki (ms.).

On Great Island, of the Three Kings group, the stock of goats which forms the subject of the present paper may have originated in part from animals introduced in the early nineteenth century; but is undoubtedly descended from four which, according to the records of the Marine Department, were placed on the island in November, 1889, to provide food for castaways.

The influence of the goats introduced to Great Island, and especially of the rapidly expanding population after 1889 (Baylis, 1948), has been imposed upon communities already considerably modified. As Baylis (ibid.) shows clearly in his account of the vegetation in this series, early Maori inhabitants cleared the island of much of the primary plant covering. Fortunately, Cheeseman (1888 and 1891) examined the vegetation in 1887, and again in 1889 when goats were liberated, and found that the greater part of the plant covering consisted of tea-tree (*Leptospermum scoparium* Forst. and *Leptospermum ericoides* A. Rich.) forest, which had evidently regenerated on the former Maori clearings.

In April, 1946, at the urgent suggestion of Mr. A. W. B. Powell, Assistant Director of the Auckland Museum, the Wild Life Branch of the Department of Internal Affairs sent an expedition of professional hunters to exterminate the then considerable goat population. The complete destruction of this population, numbering 393, by the Expedition, marks the beginning of a new phase in the ecology of Great Island: changes in both plant and animal elements in communities will now afford a unique opportunity to evaluate this major ecological factor.

I am indebted to the Department of Internal Affairs for my opportunity to visit the island as a member of the Expedition. Our party was landed on Great Island on 13th April, 1946, by the Works Department auxiliary ketch "New Golden Hind" in the course of her voyage to the Kermadec Islands. We re-embarked in the same vessel five weeks later, on 16th May.

## EFFECT OF GOATS UPON COMMUNITIES.

### (a) Plant Elements.

For a full account of the vegetation, reference should be made to the paper in this series by Baylis, who describes all modifying factors. Modification attributed to goats includes the extreme reduction or extinction of a number of plant species not referred to in the present paper.

A brief description of the effect of goats upon the vegetation, and of the vegetation quadrats, is contained in a report which I submitted to the Department of Internal Affairs on my return from the present Expedition (Turbott, 1946).

The plant covering over the greater part of the island at present consists of a sub-climax forest, with *Leptospermum ericoides* (kanuka) the sole dominant. Young *Leptospermum ericoides* grows vigorously where trees have fallen, breaking the canopy, and this species would appear to be avoided at all stages by goats (except when grazed at the seedling stage: see Appendix).

Widely scattered *Cordyline australis* (Forst. f.) Hook. f. (cabbage tree), and *Leptospermum scoparium* (manuka) in a few stands, may be locally co-dominant (Baylis, 1948). Baylis believes that *Leptospermum scoparium,* apparently to some degree palatable to goats, may have been replaced extensively by *Leptospermum ericoides.*

An extremely sparse undergrowth may be formed by two goat-resisting shrubs, *Coprosma rhamnoides* A. Cunn. and *Myoporum laetum* Forst. f. (ngaio); these even attaining subdominance (Baylis, ibid.) in certain areas. A few low plants and seedlings of *Melicope ternata* Forst. (wharangi) also occur, ranging in height from a few feet to three inches. These, although browsed or ring-barked (Fig. 15), are apparently unpalatable enough to survive, if only temporarily; no moderately high saplings of this species were observed, so that it is to be presumed that many of the young plants fail to survive.

The forest floor, particularly where the canopy is less dense, has a thick covering of the drooping sedge *Carex testacea* Boott., replaced to an increasing extent on damper ground by the more erect *Carex virgata* Hook. f. With these is mingled sparingly a third sedge, *Scirpus nodosus* Rottb. Between the sedges various mosses, grasses and herbs may be interspersed to form a matted turf.

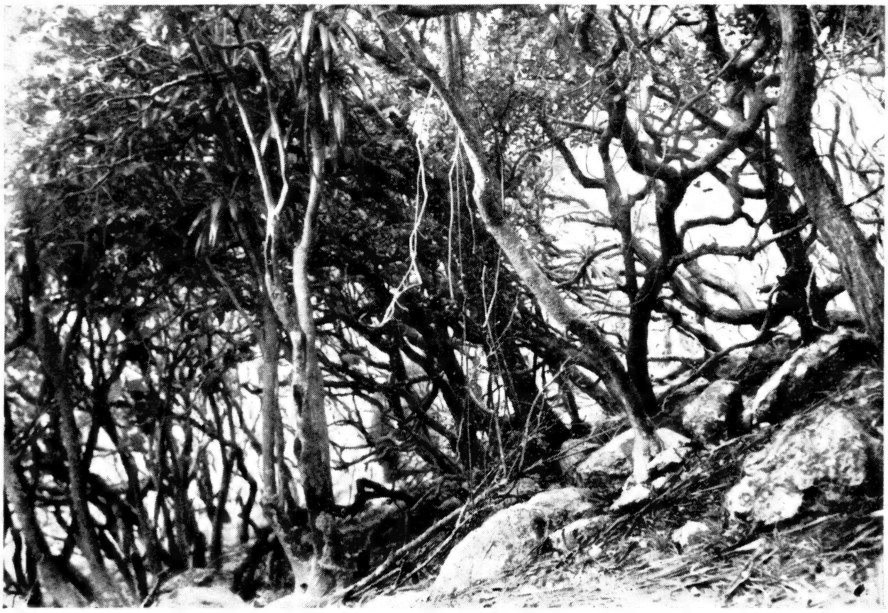


Fig. 3. A. Quadrat I, 29th April, 1946: area of south-west corner, showing *Clematis indivisa;* trunks of *Pittosporum fairchildii* (centre) and *Melicope ternata* (right); scattered *Carex testacea* on forest floor.

Fig. 4. B. Quadrat I, 6th May, 1946: south-western section, showing (left foreground) *Paratrophis smithii, Melicope ternata; Cordyline australis;* and (middle distance) *Litsaea calicaris.* Note *C. australis* barked by goats. Forest floor almost bare.

Fig. 5. C. Quadrat I, 29th April, 1946: area of north-west corner, showing young *Leptospermum ericoides* in opening, and *Cordyline australis*; dense *Carex* spp. and associated plants of ground layer.

Fig. 6. D. Quadrat I, 6th May, 1946: north-western section, showing (left) young *Leptospermum ericoides* replacing dead trees, and (right) *Litsaea calicaris*. Dense ground layer.

*Leptospermum ericoides* also forms shrubland and prostrate scrub, described thus by Baylis (ibid.) according to the growth-form of the dominant. *Leptospermum ericoides* shrubland occurs on areas considered to have been comparatively recently burnt, and *Leptospermum ericoides* scrub on part of the southern Tasman Valley where the effect of wind is particularly marked.

*Leptospermum ericoides* communities are replaced in only one considerable area by one of a different type: this is on the southern slopes of Tasman Valley, which is clothed over a considerable area by grassland, the dominant species being *Zoisia matrella* (L.) Merrill. Baylis (ibid.) considers that this grassland became established after relatively recent burning, and that slow invasion by the neighbouring *Leptospermum ericoides* shrubland had been taking place in the presence of goats.

Brief reference may be made to a sprawling scrub formed of *Myoporum laetum* on the screes and steep faces of seaward slopes; and to the small amount of unaltered shrubby and herbaceous vegetation, surviving only on the few cliff ledges inaccessible to goats.

The most remarkable characteristic of the vegetation, thus briefly described, is the extent and uniformity of the predominating *Leptospermum ericoides* communities. Of particular interest, therefore, especially in relation to the probable course of regeneration on the island, is the existence, scattered at wide intervals, of a number of groves and single individuals of large-leafed trees. These are to be regarded as remnants of the original climax forest, having probably persisted throughout the Maori occupation, in most cases on areas too rocky for cultivation. The original plant covering of Great Island is considered by Baylis (ibid.) to have consisted of a mixed coastal or semi-coastal forest, including certain endemic trees and shrubs which would have contributed a unique aspect.

At the time of the destruction of goats it was evident that climax remnants, including both trees and lianes, were of but impermanent status. The following list includes the more important species, given in order of frequency: *Metrosideros excelsa* Gaertn. (pohutukawa), *Melicope ternata* Forst. (wharangi), *Melicytus ramiflorus* Forst. (mahoe), *Litsaea calicaris* (A. Cunn.) Hook. f. (mangeao), and *Paratrophis smithii* Cheesem. A number of species, including *Pittosporum fairchildii* Cheesem. and others endemic to the Three Kings, were represented only by a few or by single individuals.

Although these were in many cases flowering or fruiting vigorously upon our arrival, seedlings or young plants were entirely absent, except in the case of *Melicope ternata,* to which reference is made above. Individuals appeared in most cases to be fully mature, and exhibited much dead wood, probably as the result both of extreme age and of direct attack by goats. It was particularly noticeable that on these highly-palatable trees foliage existed only above the reach of goats, which are capable of browsing at a maximum height of approximately five feet.

A number of trees were ring-barked, an arresting example being a large *Hiemerliodendron brunoniana* (Endl.) Skottsb. (bird-catching tree), which fell on the northern cliff face during an easterly storm in April. The trunk had been weakened and opened to fungal and insect attack by constant ring-barking, and the surrounding forest had been thinned so that the tree was open to the full force of the wind.

Briefly, the tendency of *Leptospermum ericoides* communities to predominate in the present vegetation may be attributed to two principal modifying factors: first, the widespread establishment of *Leptospermum* after Maori occupations, and second, the selective effect of grazing and browsing by a considerable goat population during the following period.

Succession would be expected to have been towards climax forest at the end of the periods of Maori clearing. The influence of goats, following upon regeneration by *Leptospermum*, had resulted in the establishment of a predominating subclimax community, the *Leptospermum ericoides* forest association.

Had goats remained on the island, remnants of the primary forest must ultimately have given place to the all-invading *Leptospermum ericoides* communities. Plants incapable of withstanding grazing or browsing, including the seedlings of most woody plants and many herbs, had already been wholly or partly suppressed for a long period; obvious maturity or old age suggesting forcibly the impermanence of primary forest remnants.

### (b) Animal Elements.

Observations and collections by several zoologists indicate the indirect influence of the goat population upon other animals in the communities through modification of the vegetation. The opportunity is taken in this paper to discuss published material and certain additional observations, which may be significant should future analyses of the animal elements be made. Valuable comparison will be possible with animal elements on other islands of the group, when these have been fully examined, as has been indicated by Baylis (ibid.) with respect to the vegetation.

### (1) Birds.

The island has a greatly impoverished land bird fauna. The following table compares the resident indigenous forest-inhabiting species of Great Island with those of three other offshore islands or groups (Buddle, 1941 and 1946; Turbott, 1940 and 1947).

Fig. 7. E. Quadrat I, 6th May, 1946: north-eastern section, showing (foreground) *Cordyline australis*, (centre right) *Melicope ternata*, and (left) young *Leptospermum ericoides* near north-east corner.

Fig. 8. F. Quadrat I, 29th April, 1946: eastern section, showing tall *Leptospermum ericoides* forest; ground layer with dense *Carex* spp. and associated plants.

| | Little Barrier Island (7000 acres) | Hen Island (1175 acres) | Poor Knights Islands (480 acres) | Great Island (1000 acres) |
|---|---|---|---|---|
| *Apteryx australis* Shaw, kiwi .. .. | + | | | |
| *Hypotaenidia philippensis* (L.), banded rail | X | | X | X |
| *Porzana tabuensis* (Gm.), spotless crake | | | X | X |
| *Hemiphaga novaeseelandiae* (Gm.), pigeon | X | X | | |
| *Nestor meridionalis* (Gm.), kaka .. | X | X | | |
| *Cyanoramphus novaezelandiae* (Sparrm.), red-fronted parakeet .. .. .. | X | X | X | X |
| *C. auriceps* (Kuhl), yellow-fronted parakeet .. .. .. .. .. | X | X | | O |
| *Ninox novaeseelandiae* (Gm.), morepork | X | X | | X |
| *Halcyon sanctus* V. & H., kingfisher .. | X | X | X | X |
| *Acanthisitta chloris* (Sparrm.), rifleman | X | | | |
| *Pseudogerygone igata* (Q. & G.), grey warbler .. .. .. .. .. | X | X | | O |
| *Petroica macrocephala* (Gm.), tit .. | X | X | | |
| *Miro australis* (Sparrm), robin .. .. | X | | | |
| *Rhipidura fuliginosa* (Sparrm.), fantail .. | X | X | | X |
| *Mohoua ochrocephala* (Gm.), whitehead | X | | | |
| *Zosterops lateralis* (Lath.), silvereye .. | X | X | | |
| *Prosthemadera novaeseelandiae* (Gm.), tui | X | X | | O |
| *Anthornis melanura* (Sparrm.), bell bird | X | X | X | X |
| *Notiomystis cincta* (Du Bus), stitch bird | X | | | |
| *Creadion carunculatus* (Gm.), saddleback | O | X | | |

+ probably from introduced stock. O recorded formerly.

Continued modification of the vegetation by goats would appear to be primarily responsible for the small number of species now occurring on Great Island. The other islands listed are essentially unmodified, being clothed in mixed forest or scrub.

On the Poor Knights group (approximately 480 acres) the vegetation is a mixed coastal scrub with a small amount of coastal forest, which would tend to some degree to limit such species with special food requirements as *Nestor meridionalis* (kaka) and *Hemiphaga novaeseelandiae* (pigeon) (Turbott, ms.). The small populations which the area could support may also have resulted in the elimination of species through factors of genetic composition (Huxley, 1942; Mayr, 1942). The small number of species and environmental conditions of the Poor Knights are closely paralleled on South West Island (approximately 70 acres), an unmodified smaller member of the Three Kings group (Buddle, 1948).

Such limits of vegetation and area would not appear to have affected the original bird fauna of Great Island. It will be seen that the island approximates in area to Hen Island, which has a much greater number

of species. The original vegetation is considered by Baylis (1948) to have been a "mixed coastal or semi-coastal forest with the same dominant species as may be found on the mainland and other coastal islands."

In August, 1887, Cheeseman (1888) observed two forest-inhabiting species, *Prosthemadera novaeseelandiae* (tui) and *Pseudogerygone igata* (grey warbler), which are now absent*; and a further now unrepresented species, *Bowdleria punctata* (Q. & G.) (fern-bird), an inhabitant of scrub and swamp vegetation on the mainland. Cheeseman also noted *Zosterops lateralis* (silvereye), a species recorded recently only as a straggler. Athough Cheeseman only lists these species, giving no indication of their breeding status, it seems probable that they were in fact resident at the time of his visit.

Two of these species, *Pseudogerygone igata* and *Zosterops lateralis*, were also recorded by Cheeseman on South West Island in the spring of 1889 (Cheeseman, 1891), but are apparently now absent (Buddle, 1948). Their possible extinction on this adjacent unmodified island would suggest that the persistence of the smaller population might have depended upon an occasional influx from Great Island.

A further species, *Cyanoramphus auriceps* (yellow-fronted parakeet) was recorded as late as 1934, but not during recent visits (Turbott and Buddle, 1948).

These species have apparently succumbed as the result of the continued influence of goats upon the vegetation. It may be suggested that others, such as *Hemiphaga novaeseelandiae* (pigeon) and *Nestor meridionalis* (kaka), were originally present, but were destroyed as food or through modification of the vegetation during the Maori occupations.

It would not have been beyond the powers of dispersal of most of the now unrepresented species to recolonise Great Island from the mainland, approximately thirty-five miles distant, but with the progressive impoverishment of the vegetation by goats such re-establishment would have been impossible. It may be noted that Watt (1947) records *Hemiphaga novaeseelandiae, Pseudogerygone igata, Bowdleria punctata* and *Zosterops lateralis* as numerous on the immediately adjacent mainland. Mr. A. H. Watt, of Paua, has informed me (in litt.) that in 1948 one individual of *Prosthemadera novaeseelandiae* appeared there as a straggler; this and other forest-inhabiting birds are established approximately sixty miles to the south, beyond the low-lying narrow northern isthmus.

Populations of the species of indigenous land birds at present occurring on Great Island may also be considered to reflect strongly the modificaton of the vegetation. Only one species, *Anthornis melanura*† (bell bird) has a high population density, being abundant throughout the

* Johnson (1946) has published a record of *Prosthemadera novaeseelandiae* as having been observed on 1st January, 1945. Major M. E. Johnson has informed me that, after further observation on subsequent visits, he regards his identification as probably mistaken.

† Described as subsp. nov. in this series by Falla (1948).

Fig. 9. G. Quadrat II, 27th April, 1946: area of north corner (peg and flag centre left), showing *Leptospermum ericoides* forest; on ground layer, turf and scattered *Carex* spp.

Fig. 10. H. Quadrat II, 27th April, 1946; north-eastern side of quadrat near north corner peg. Young *Leptospermum ericoides* (right); scattered *Carex* spp., *Scirpus nodosus* and turf on forest floor.

*Leptospermum ericoides* forest. Although flowers bearing nectar are few, this particularly adaptable species has evidently become adjusted to a predominantly insectivorous diet.

Of the remaining indigenous birds, the numbers of *Anthus novaeseelandiae* (Gm.) (pipit) may be placed following, but considerably below, those of *Anthornis melanura.* This species occupies a special niche on Great Island in that it penetrates the characteristic parklike forest, habitually perching on the trees and feeding on the more open parts of the forest floor. It is found also on the grassland area, and on the shore, which is its normal habitat on densely forested islands.

*Ninox novaeseelandiae* (morepork) is fairly abundant, such food as lizards, insects, and the considerable numbers of *Anthornis melanura*, being plentiful.

There is a marked contrast in the population density of the five other indigenous forest-inhabiting species. *Cyanoramphus novaezelandiae* (red-fronted parakeet) and *Halcyon sanctus* (kingfisher) occur in moderate numbers only, and *Rhipidura fuliginosa* (fantail) is represented by a small population of probably not more than fifty for the whole island (approximately 1,000 acres).* This estimated population for the last species may be compared directly with my count of nine breeding pairs occupying seventy-five acres of mixed forest on Hen Island, a density representing 240 per 1,000 acres (Turbott, 1940).

Of the two forest floor species, *Hypotaenidia philippensis* (banded rail) occurs in small numbers, and *Porzana tabuensis* (spotless crake) has been recorded (Turbott and Buddle, 1948) only on two occasions.

Nine species of naturalised passerine birds from the mainland have become established on Great Island: *Fringilla coelebs L.* (chaffinch), *Carduelis cabaret* (P.L.S. Mull.) (redpoll), *Carduelis carduelis* (L.) (goldfinch), *Passer domesticus* (L.) (house sparrow), *Emberiza citrinella* L. (yellowhammer), *Turdus ericetorum* Turt. (song thrush), *Turdus merula* L. (blackbird), *Prunella modularis* (L.) (hedge sparrow) and *Sturnus vulgaris* L. (starling). Most of these penetrate more deeply into the open *Leptospermum ericoides* forest than into mixed forests on the mainland. It would be expected that they might, under these conditions, tend to predominate over indigenous species, but all, with the exception of *Turdus merula,* are represented by small populations. Although, with widespread modification, competition might be expected to have been sharpened to an even greater degree than is usual on small islands (Mayr, 1942), none of these species would appear to have exerted a marked influence upon the indigenous birds. *Turdus merula*, which has advanced into a wide range of habitats, including forest, throughout New Zealand, is only moderately plentiful; this species may, as Buddle (1941, 1948) suggests in referring to the Poor Knights and South West Island, compete to some degree for food with the indigenous rails.

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* Turbott and Buddle (1948) discuss the effect of these small numbers upon the establishment of a mutant element in the population of *Rhipidura fuliginosa.*

A species of *Synoicus** (brown quail) is present in moderate numbers in more open parts of the forest, where insects and fruits of grasses and sedges provide an abundant food supply not comparable with that of any other species.

It should be noted that the above references to population densities are based upon estimates: it was unfortunately not possible to carry out census work which would have permitted of direct comparison with the mainland or other islands (Turbott, 1940).

Comparison of total population densities in various habitats with Great Island would also be of value. My observation would suggest a much lower total density in forest on Great Island than on unmodified offshore islands (Turbott, 1940, 1947 and ms.).

Factors which appear to have controlled the number of species and populations of land birds on Great Island may be stated briefly. The primary influence is considered to have been that of goats through the continued modification of the vegetation. Of predatory birds, numbers of *Ninox novaeseelandiae* (morepork) would not appear to predominate in relation to other species; *Circus approximans* Peale (harrier) is represented by not more than six individuals probably ranging freely over the group. The small populations of the naturalised species would appear insufficient to have markedly influenced the indigenous species through competition.

The status of two of the present indigenous species is of particular interest. *Cyanoramphus novaezelandiae* (red-fronted parakeet) appears to have decreased considerably in numbers since 1934 (Turbott and Buddle, 1948). *Porzana tabuensis* (spotless crake) is extremely rare on Great Island, although forming a vigorous, breeding element on South West Island (Buddle, 1948); on this unmodified island it has the same status as on the Poor Knights (Buddle, 1941, 1946). The factors indicated above have brought about a particularly marked reduction in the numbers of both species, *Porzana tabuensis* having almost reached the point of extinction.

In the case of the sea birds, the presence of goats has undoubtedly to some degree affected the area available for nesting to various petrels and to *Larus novaehollandiae* Steph. (red-billed gull), which breed on Great Island in large numbers. Three of the five known species of breeding petrel, *Puffinus gavia* (Forst.) (fluttering shearwater), *Pelecanoides urinatrix* (Gm.) (diving petrel) and *Pterodroma macroptera* (Smith) (grey-faced petrel) occur in considerable numbers, but all tend to be restricted to cliff faces and other areas not invaded by dense ground vegetation. The distribution of breeding petrels must also be affected directly by general hardening of the soil and by trampling. On unmodified islands the burrows of these and other species, although in many cases in more or less compact colonies, occur throughout the forest or scrub.

* Possibly a species of *Synoicus* indigenous to New Zealand rather than the naturalised *Synoicus ypsilophorus* (Bosc.) (Turbott and Buddle, 1948).

Fig. 11. J. Quadrat II, 27th April, 1946: south-western side, over south corner peg (left foreground). *Melicope ternata* to right. Dense floor -covering of *Carex* spp.

Fig. 12. K. Quadrat III, 28th April, 1946: north-western side over west corner peg (foreground). *Zoisia* sward with *Scirpus nodosus; Leptospermum ericoides* (height five feet) in north corner. In distance *L. ericoides* forest on northern side of Tasman Valley.

The large colonies of *Larus novaehollandiae* have also been restricted to areas relatively free from disturbance by goats, although reduction of the vegetation would have provided open nesting places not originally available.*

Finally, in considering factors affecting both land and sea birds it is necessary to take into account the complete absence of naturalised predatory mammals, cats, rats and mustelids being absent from this and other members of the Three Kings group.

## (2) Invertebrates.

As the result of the work of Powell (1935 and 1948) the land molluscs of Great Island are better known than other invertebrate groups. This author attributes the extremely limited range of the large herbivorous snail *Placostylus bollonsi* Suter primarily to the clearing of the original forests by Maori inhabitants. The population has subsequently been restricted, and probably reduced, to three small isolated colonies by the direct trampling effect of goats and the limited range of suitable food plants. Two colonies occur on rocky areas associated with small groves of large-leaved trees, the fallen leaves providing a normal food-supply. The third exists under apparently less favourable conditions on a rocky seaward cliff face beneath a practically impenetrable band of *Myoporum lactum* scrub. Powell (1948) describes members of this isolated colony as representing a new subspecies, considering that the smaller adult size has developed in adaptation to the restricted diet.

Powell (ibid.) lists eight further species of land molluscs, *Egestula gaza* (Suter) being abundant on the forest floor in *Leptospermum ericoides* forest.

The remaining terrestrial invertebrates are inadequately known. During the Expedition I collected material representing a number of groups, which in several cases await examination.

Beating in *Leptospermum ericoides* shrubland produced a restricted number of species which were in no case markedly abundant: these included leaf-hoppers and a pentatomid bug (Hemiptera); beetles (Coleoptera); and mites and spiders (Arachnida). Mr. A. E. Brookes, who has kindly informed me of the results of his preliminary examination of beetles from the island, considers that the affinities of those obtained by beating are with mainland species generally found in mixed forest, rather than in *Leptospermum* communities.

On the ground in *Leptospermum ericoides* forest, carabid and tenebrionid beetles were particularly common under fallen branches, stones and in drifts of boulders.

* Observations since the goats were destroyed indicate that the colonies of *Larus novaehollandiae* on the slopes above North West Bay and South East Bay have expanded considerably, although herbaceous and shrubby vegetation is already increasing on these areas (Turbott and Buddle, 1948).

The pupal cases of a *Porina* sp.* (Lepidoptera) were of frequent occurrence, the adults appearing at light in the evenings. A species of *Odontria* (Coleoptera) also came fairly frequently to light. The apparently considerable population of both of these insects is possibly related to the sedges, grasses and herbs of the ground layer, which would provide abundant food for the subterranean root-feeding larvae.

As indicated above, dead and dying wood was plentiful throughout the *Leptospermum ericoides* communities and especially in the climax forest remnants. This had been heavily attacked by wood-boring weevils and other beetles, and, in several cases observed, by colonies of termites (Isoptera).

### (c) Examination of stomach contents of goats killed, and observations on food habits.

There were few opportunities during the Expedition to investigate stomach contents, or to observe goats feeding, mainly because of the dispatch with which the work of destruction was carried out. Within three weeks of our arrival the population had been reduced to approximately twenty, and these were particularly wary.

Stomachs examined with the help of Mr. L. C. Bell indicated that goats were feeding largely upon grasses, sedges (particularly *Carex*) and herbaceous plants obtained by grazing. A few fragments of leaves of *Myoporum laetum* were recorded in stomach contents.

After high winds two stomachs examined contained a large proportion of leaves, including those of *Melicytus ramiflorus, Litsaea calicaris* and *Metrosideros excelsa,* and pieces of a large lichen common on *Leptospermum ericoides.* Material of this kind had been blown to the ground in considerable quantity.

Goats were observed grazing on both forest floor and grassland, moving about in typically capricious manner, but were on no occasion seen attempting to browse. Cropped sedges (*Carex* spp. and *Scirpus nodosus*) were observed, but the direct effect of grazing upon other herbaceous plants was not apparent.

As already indicated, foliage was absent on the remaining highly-palatable trees at levels which goats could reach, i.e., approximately five feet. A *Corynocarpus laevigata* Forst. (karaka) was observed upon which a number of lower leaves had been bitten in half, goats having stood upon their hind legs to browse upon the foliage.

It is of interest in relation to palatability that experiments by Cunningham and Hopkirk (1945) have shown the leaves of *Myoporum laetum* to be poisonous to sheep; a similar effect is recorded for cattle, horses and pigs.

### (d) Mechanical effect of goats.

The principal effect of goats in the communities is through modification of the vegetation as a function of food habits.

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* sp. nov. (Salmon, 1948).

Fig. 13. L. Quadrat III, 5th May, 1946: entire quadrat from approximately twenty yards beyond north-western side; west corner peg in right middle distance, east corner peg centre left. In distance, prostrate *Leptospermum ericoides* scrub on southern side of Tasman Valley.

Fig. 14. M. Quadrat III, 28th April, 1946: diagonally across quadrat from south-east side to west corner peg (left middle distance); showing *Scirpus nodosus* and wind-swept *Leptospermum ericoides*, shrubland. The ground drops steeply to the south-western cove from the skyline.

As distinct from this coactive effect, mechanical reaction is evident to a certain degree in hardening of the soil, more particularly on the crests of steep seaward slopes.

As recorded above, the constant movement of the goat population is regarded by Powell (1948) as a factor in preventing any increase or spread of the colonies of *Placostylus bollonsi.* This purely mechanical action has probably also been effective in the case of a number of other ground-living animals.

Sea bird colonies are also considered to have been affected by trampling and hardening of the soil.

## CHOICE OF LOCALITIES, AND GENERAL DISCUSSION OF QUADRATS.

The following sections of this paper consist of a detailed description, as far as possible in quantitative terms, of the vegetation of three permanent quadrats, which were established to demonstrate the course of potential changes in the plant covering.

An important consideration in planning quadrats was that the time available on this inaccessible island must tend to be short. Accordingly, some care was taken to locate the quadrats within convenient distances of landings and reference points. The description of the vegetation is in a form suitable for immediate reference, depending chiefly upon quadrat charts, accompanied by photographs and in two quadrats by supplementary lists of species.

Otherwise the choice of quadrats was influenced by two aspects of the present status of the vegetation:

(1) The destruction of the goats took place before the complete extinction of the primary forest remnants, and consequently in time to allow of the possibility that a climax forest originating from this stock would replace the widespread *Leptospermum ericoides* communities. It would be expected also that certain species with effective means of dispersal might colonise Great Island from other islands of the group, the plants of which are described in papers in this series (1948) by Baylis, Buddle and Oliver; and that colonisation may be possible from the adjacent mainland.

Quadrats I and II, consisting of *Leptospermum ericoides* forest, including, or within known distance of, groves of mixed forest trees, were chosen to indicate the course of regeneration in the more immediate neighbourhood of the climax forest remnants.

*Quadrat I*, situated in a moderately deep valley, is necessarily relatively large—40 metres square—in order to include groves of climax forest trees, together with a representative area of adjacent tall *Leptospermum ericoides* forest.

It is worth recording that two additional climax species, *Corynocarpus laevigata* and *Hiermerliodendron brunoniana*, are present in a valley within 50 yards of the quadrat to the north.

*Quadrat II* is situated in the upper portion of the same valley, where the ground is drier. Unlike Quadrat I, this quadrat represents a relatively uniform plant covering, and is accordingly only 15 metres square. The vegetation, consisting of uniform *Leptospermum ericoides* forest of moderate height, is perhaps more characteristic than that of Quadrat I of the greater part of the island. The quadrat is approximately 75 yards from the climax forest trees of Quadrat I, and was chosen with a view to demonstrating regeneration in *Leptospermum ericoides* forest separated by at least a moderate distance from the nearest forest remnants.

(2) The future of the Tasman Valley *Zoisia* sward will be of particular interest, especially in view of the suggestion (Baylis, 1948) that it was in the course of invasion before the destruction of goats by *Leptospermum ericoides* shrubland.

*Quadrat III* is situated in *Zoisia* sward, bordering on hummocky patches of low *Leptospermum ericoides.* A quadrat 15 metres square was sufficient to include typical patches of *Leptospermum ericoides* shrubland together with adjacent sward. On this quadrat changes in the sward will be readily observed, and the quadrat will be interesting in demonstrating the potentialities for invasion of the *Leptospermum ericoides* shrubland in the absence of goats. The effect of wind, as reflected in, the growth-form of the adjacent *Leptospermum ericoides* shrubland and prostrate scrub, may be of some importance in controlling the vegetation on this quadrat.

## LOCATION OF QUADRATS.

(1) *Marks.* Each quadrat is a square, the corners being marked by a half-inch galvanised iron pipe driven well into the ground and surrounded by a strongly-built cairn of large stones. For purposes of observation a rough standard bearing a white flag was fitted into every pipe, but these will probably not remain intact for more than six months. (Figs. 9 and 12).

The corner pegs of the quadrats should not be confused with the wooden pegs, painted white and numbered 1-4, which were used to mark seedlings in or near Quadrat I.

(2) *Directions for locating quadrats. In order to find the position of the quadrats it will be necessary for future observers to take with them a prismatic compass.* The bearings given below are all magnetic.

*Quadrats I and II* are close together in the first valley to the east of the castaway depot,* after crossing the saddle between North West Bay and South East Bay (Fig. 1).

*Quadrat I* is reached by walking to a prominent inland rock on the first ridge to the north-east across the saddle between North West Bay and South East Bay; the bearing of this rock over the centre of the depot is 34°. (It appears probable that actively growing *Leptospermum ericoides* will tend increasingly to obscure visibility from the depot

* It is anticipated that the depot will survive as a recognisable reference point for a number of years.

Fig. 15. *Melicope ternata* six feet in height browsed and ring-barked by goats, Quadrat I, 25th April, 1946.

Fig. 16. New shoots near ground level on *Paratrophis smithii* after destruction of goats, Quadrat I, 6th May, 1946.

Fig. 17. New shoot four feet from ground on *Tetrapathaea tetrandra*, clinging to *Leptospermum ericoides* in lower part of photograph. Note old shoot nipped off by goats against palm of hand. Quadrat I, 6th May, 1946.

itself.) Upon reaching the rock, the observer should move round to the left until above it; then, at a bearing of 65°, walk approximately 85 yards to the south-west corner peg of the quadrat. The peg is placed in a pocket amongst rocks and is at present adjacent to a grove of mixed trees (see plan of quadrat, Fig. 20). From this peg the bearing of the west side of the quadrat is 6°.

*Quadrat II* is approached from above the same inland rock as in the directions for Quadrat I. From here at a bearing of 350° a distance of approximately 80 yards leads to the west corner peg of the quadrat. From the peg, which is on a moderate slope, the bearing of the N.W. side of the quadrat is 39°.

*Quadrat III* is some distance from the castaway depot, being situated in the area covered at present by grassland on the south side of Tasman Valley (Fig. 1).

The quadrat is near the lowest point of a saddle (Fig. 2) close to the south-west coast of the island. This low saddle is clearly outlined from any point on the ridge to the south-west of the depot, but may be identified exactly as bearing 167° from a prominent rounded rock which stands out on this ridge. After crossing the Tasman Valley to reach the lowest point of this saddle, the observer will find as a landmark a yellowish weathered rock, about six feet high, on the crest of the steep seaward slope above the south-western cove. From this rock walk back for approximately 95 yards at a bearing of 334° to reach the south corner peg of the quadrat. The bearing of the south-east side of the quadrat from this peg is 14°.

## VEGETATION OF THE QUADRATS.

*Method of description.* Field identifications have been checked by specimens referred in the case of vascular plants to Dr. G. T. S. Baylis, of lichens to Dr. H. H. Allan, and of mosses to Mr. G. O. K. Sainsbury. Specimens from the quadrats have been placed in the herbarium of the Auckland Museum.

The vegetation of the quadrats is described by means of (1) the quadrat charts, together with supplementary lists of physiognomic species in the case of Quadrats II and III; (2) photographs showing certain portions of the quadrats.

The degree of quantitative detail represented by the charts was governed by the time available in the field. The quadrats had necessarily to be of relatively large area in order to include representative areas of forest or shrubland, and it was correspondingly impossible to attempt quantitative description of the ground layer over the full area of the quadrats. Thus in the ground layer physiognomic species only are indicated, according to distribution.

Had more time been available, ground layer quadrats of one or a few metres could with advantage have been established.

Non-physiognomic herbs which occurred on the quadrats, especially on the forest floor in Quadrats I and II, are omitted from my description; species falling under this category being, in general, those referred to as "common" or "abundant" by Baylis (1948) and Oliver (1948).

The vertical structure of the vegetation is indicated by the photographs alone; the construction of profile diagrams was not undertaken.

The two charts for Quadrat I accompanying this paper have been reconstructed from a field chart, upon which both canopy and ground layer were plotted. In the field, position and extent of foliage of the canopy trees, and distribution of the ground layer species, were indicated by the initial letters of generic and specific names; in plotting the canopy, letters of varying size were used to indicate the extent of the individual crown.

The procedure in plotting was to record each strip of two metres passing from side to side of the quadrat, the ends and mid-points of successive strips being marked by a temporary flag.

A similar procedure was adopted in recording the less varied vegetation of Quadrats II and III.

### Quadrat I.

Figs. 20 and 21 (charts); and Figs. 3 to 8, and 15 to 17 (photographs).

Of the charts for Quadrat I, Fig. 20 represents, in plan, the position and status of every individual woody plant. Fig. 21 indicates the distribution of physiognomic species forming the ground layer. The following brief general account completes the description of the quadrat.

The forest of Quadrat I, and on all parts of the island accessible to goats, may be divided primarily into two main layers, the canopy and the forest floor. The canopy layer is regarded as that comprising the dominant tall tree, *Leptospermum ericoides*, of height 20 to 30 feet, the growth-form of which is high-crowned; and the scattered climax trees on which foliage is present only above five feet, the approximate browsing level reached by goats.

The climax forest trees for the most part form a conspicuous element in the canopy; but in some cases individuals may be lower than, and to some degree overshadowed by, the tall *Leptospermum ericoides*, these also being regarded as part of the canopy. The heights vary from *Litsaea calicaris* reaching 25 feet, to *Pittosporum fairchildii*, 15 feet.

Between the canopy and the ground layer the forest is characteristically open and free of undergrowth, except for scattered shrubs, and young or low-growing plants, regarded as unpalatable to goats (Fig. 20B). The commonest species is *Melicope ternata*, individuals ranging in height from 3 to 36 inches.

In the north and north-east portions of the quadrat there are two aggregations of regenerating *Leptospermum ericoides* up to 15 feet in height, filling a gap in the canopy where large trees have fallen.

As indicated by the charts and photographs, the forest floor under tall *Leptospermum ericoides* is clothed in a dense ankle- to knee-deep carpet of the two species of sedge, *Carex testacea* and *Carex virgata;* but is practically bare, with a deposit of somewhat dry leaf-mould, in

Fig. 18. N. Quadrat III, 28th April, 1946: south-eastern side of quadrat, showing dense hummock of *Leptospermum ericoides* (height two feet) near south corner; *Scirpus nodosus;* and *Zoisia* sward.

Fig. 19. Quadrat III, 1st January, 1948: from approximately the same position and angle as Fig. 18, showing abundant seed heads on sward.

Photo. G. T. S. Baylis.

the heavy shade of the grove of mixed trees in the south-west corner (Figs. 3 and 4), and under the dense canopy of young *Leptospermum ericoides* to the north.

The ground is rocky in the south-west and north-west corners of the quadrat, and along the dry watercourses, providing in damper areas a characteristic habitat for the tall-growing fern *Pteris comans* Forst. f.

It may be noted finally that the fern *Doodia media* R. Br. differs markedly according to amount of shade and moisture, becoming much reduced in size and being red in colour under openings near the northern margin.

*Regeneration observed during the Expedition.* Destruction of goats was proceeding throughout the period of field work on the quadrats, and it is probable that after 25th April, when large numbers of goats had already been killed, there was little normal feeding by the remaining frightened animals.

From 1st May all members of the expedition were impressed by the vigorous growth of young grass and herbs, and of soft new shoots which appeared at a low level on several species. This was particularly apparent in the case of *Cordyline australis* (cabbage tree), upon which growth of new shoots occurred near the base of the trunk.

On Quadrat I, low branches of *Paratrophis smithii* were bearing young shoots by 6th May (Fig. 16); and regrowth was vigorous on the vine of *Tetrapathaea tetrandra* (DC.) Cheesem. just outside the north-west corner of the quadrat (Fig 17).

On 6th May two seedlings of *Colensoa physaloides* (A. Cunn.) Hook. f. three inches high were recorded on the north side of the quadrat, where the edge of the quadrat intersects the dry stream bed.

Most species of the climax forest remnants on the quadrat were producing abundant seed during April and May.

Numerous small seedlings had appeared by May in the neighbourhood of the grove of mixed trees and vines of *Clematis indivisa* Willd. in the south-west corner of the quadrat, but in most cases could not be identified in the field.

Of these, two seedlings which appeared almost certainly to be *Litsaea calicaris,* and two young plants of *Melicope ternata,* were marked with numbered pegs of durable wood painted white. The pegs were, in every case, placed one foot to the north with the number facing the specimen (Fig. 20). Seedlings marked thus were:—

*Peg number*

1. *Melicope ternata,* height 6 inches.
2. *Litsaea calicaris,* height 1 inch.
3. *Melicope ternata,* height 4 inches.
4. *Litsaea calicaris,* height 2 inches.

Elsewhere than on Quadrat I seedlings were observed in the neighbourhood of groves of mixed trees, but were in most cases too small for identification. Mr. L. C. Bell, in examining a heavily-fruiting specimen of *Sideroxylon novo-zelandicum* (F. Muell.) Hemsl. (tawapou) above South East Bay shortly before our departure, found numerous seedlings which had just appeared through the leaf-mould.

## Quadrat II.

Fig. 22 (chart); and Figs. 9 to 11 (photographs).

On the chart both canopy and forest floor are represented, the whole having been reduced to diagrammatic form indicating only certain important aspects of the vegetation. Less time was spent in field work on this quadrat than on Quadrat I, the vegetation being relatively uniform, and essentially of the same composition as that part of Quadrat I consisting of *Leptospermum ericoides* forest.

In general, the canopy is lower and more open than in Quadrat I. The canopy layer is formed by 46 individual *Leptospermum ericoides*, of an average height of 18 to 20 feet; the trunks range in diameter from $3\frac{1}{2}$ to 8 inches. The only other species reaching the canopy is *Cordyline australis*, represented by a single individual in the extreme eastern corner, of height eighteen feet.

Three *Leptospermum ericoides* had recently fallen, leaving gaps in the canopy; in one gap larger than the others in the eastern corner a small group of young *Leptospermum ericoides* had sprung up, reaching a maximum height of six feet.

Low rounded shrubs of *Coprosma rhamnoides* are scattered over the quadrat.

The forest floor on the southern one-third of the quadrat, where the ground is damp, supports the characteristic dense sedge (*Carex testacea* and *Carex virgata*). *Carex testacea* continues towards the drier shoulder of the ridge, becoming progressively shorter and more sparse and giving place over increasing areas to a short turf of grasses, mosses and herbs.

The fern *Doodia media* is plentiful throughout the quadrat, taking on a reduced and flattened growth-form in drier conditions under the open canopy.

The following list includes the physiognomic species composing the short turf, and certain herbaceous species growing through the turf throughout the quadrat:

### MOSSES.

*Thuidium furfurosum* (Hook. f. and W.) Jay.

### GRASSES.

*Oplismenus undulatifolius* Beauv.
*Echinopogon ovatus* (Forst. f.) Beauv.
**Aira praecox* L.

* Introduced into New Zealand.

Subdivisions :

A. POSITI(
VIDUAL
WITH
LEVEL

A formal:
*Cordyline aust*
primary fores

**Lc**

**Le**

**Mr**

**Mt**

**Pf**

**Ps**

B. POSITIC
FEET.
Symbols r
*permum ericoi*

**1-4**

Arrows A
intended to be
photographs a

Elsewhere than on Quadrat I seedlings were observed in the neighbourhood of groves of mixed trees, but were in most cases too small for identification. Mr. L. C. Bell, in examining a heavily-fruiting specimen of *Sideroxylon novo-zelandicum* (F. Muell.) Hemsl. (tawapou) above South East Bay shortly before our departure, found numerous seedlings which had just appeared through the leaf-mould.

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The following list includes the physiognomic species composing the short turf, and certain herbaceous species growing through the turf throughout the quadrat:

### MOSSES.

*Thuidium furfurosum* (Hook. f. and W.) Jay.

### GRASSES.

*Oplismenus undulatifolius* Beauv.
*Echinopogon ovatus* (Forst. f.) Beauv.
**Aira praecox* L.

* Introduced into New Zealand.

Subdivisions are two metres square.

Fig. 20.

A. POSITION AND APPROXIMATE EXTENT OF INDIVIDUALS FORMING CANOPY, INCLUDING ALL TREES WITH FOLIAGE ABOVE FIVE FEET (APPROXIMATE LEVEL REACHED BY GOATS).

A formalised outline represents position and area of every crown. For *Cordyline australis* a symbol represents position only. Double outlines denote primary forest species.

- **Lc** —*Litsaea calicaris* (mangeao).
- **LE** —*Leptospermum ericoides* (kanuka).
- —*Leptospermum ericoides*—dead, still standing.
- **MR** —*Melicytus ramiflorus* (mahoe).
- **MT** —*Melicope ternata* (wharangi).
- **PF** —*Pittosporum fairchildii.*
- **PS** —*Paratrophis smithii.*
- —*Clematis indivisa*—outline includes group of roots.
- —*Tetrapathaea tetrandra*—rooted outside the quadrat.
- —*Cordyline australis* (cabbage tree).

B. POSITION OF INDIVIDUAL WOODY PLANTS BELOW FIVE FEET.

Symbols represent position only, except in the case of young *Leptospermum ericoides.*

- —*Coprosma rhamnoides.*
- —*Melicope ternata*—including young plants and seedlings.
- —Ditto, exhibiting damage by goats (defoliation and ring-barking).
- —*Myoporum laetum* (ngaio).
- —Ditto, damaged by goats.
- —*Leptospermum ericoides*, young.
- **1-4** —Position of young plants and seedlings marked by numbered pegs.

Arrows A-F indicate angle of photographs (Figs. 3 to 8), which are intended to be examined in conjunction with charts. Position and angle of photographs are approximate.

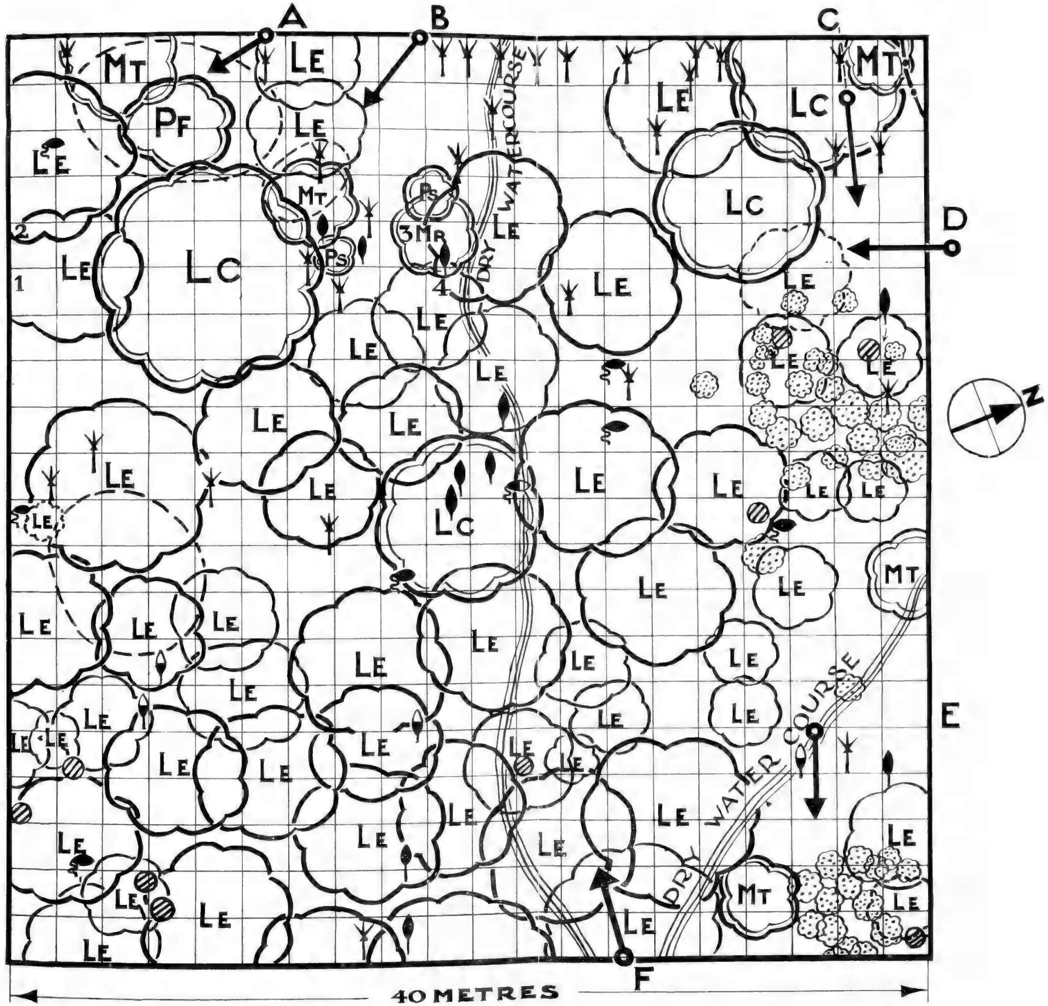


Fig. 20. PLAN OF QUADRAT I, charted 26th April to 14th May, 1946. Canopy; shrubs below level reached by goats; and seedlings of woody plants.

#### HERBS.

*Oxalis corniculata* L.
*Haloragis procumbens* Cheesem.
*Centella asiatica* (L.) Urban
*Dichondra repens* Forst.
*Lobelia anceps* L.
*Wahlenbergia gracilis* (Forst. f.) Schrad.
*Gnaphalium collinum* Lab.

### Quadrat III.

Fig. 23 (chart); and Figs. 12 to 14 and 18 to 19 (photographs).

This quadrat is situated in typical *Zoisia* sward bordering on wind-swept *Leptospermum ericoides* shrubland.

The substratum is rocky, as over most of the Tasman Valley grassland. The ground upon which the quadrat is placed appears to be a little damper than most of the grassland area, and may represent a region of slight seepage.

The quadrat encloses part of two clumps of *Leptospermum ericoides*. That to the south is moulded by wind into a dense cushion not more than two feet high. The other, in the northern corner, is part of a patch reaching five feet in height, tall enough to have been penetrated by goats in search of shelter.

In marked contrast to the closely-cropped sward, the ground species beneath the patches of *Leptospermum ericoides* have a straggling growth-form, and even grow luxuriantly under the denser cushions, which appear to afford a certain degree of protection from goats.

*Carex testacea* appears in the shade of these clumps, and abundant *Scirpus nodosus* rises through the wind-shorn hummocks. The growth-form of the fern *Doodia media* is here in particularly marked contrast with that on the sward, being green in colour with loose, spreading fronds.

The following grasses and herbaceous species were recorded under the patch of *Leptospermum ericoides* in the north corner of the quadrat:

#### GRASSES.

*Oplismenus undulatifolius* Beauv.
*Danthonia semiannularis* R. Br.

#### HERBS.

*Hydrocotyle novae-zealandiae* DC.
*Dichondra repens* Forst.
*Gnaphalium collinum* Dab.

The remainder of the quadrat is covered by a short, even sward composed of the following lichens, mosses, grasses and herbaceous species:

#### LICHENS.

*Cladonia floerkeana* (Fr.) Somm.

#### MOSSES.

*Thiudium furfurosum* (Hook. f. and W.) Jay.
*Leptodontium interruptum* (Mitt.) Broth.
*Campylopus introflexus* (Hedw.) Mitt.

**GRASSES.**

*Zoisia matrella* (L.) Merrill
*Deyeuxia crinita* (L.) Zotov

**HERBS.**

*Oxalis corniculata* L.
*Centella asiatica* (L.) Urban
*Gnaphalium collinum* Lab.

The fern *Doodia media* is scattered sparsely over the open sward, assuming a reddish colour and almost a rosette growth-form in this situation.

The sedge *Scirpus nodosus* is particularly abundant on the sward, scattered irregularly throughout, either individually or in extensive colonies.

*Note on regeneration observed during the Expedition.* By 1st May, at which time there was practically no grazing, the sward had lost much of its close-cropped appearance. New grass shoots, springing up after heavy rain, were already taller than the other elements in the sward.

## NOTES ON CHARACTERS OF GOATS.

The following observations were made on the animals destroyed. A more detailed record of sex and other characters was attempted but, unfortunately, proved impossible during shooting operations.

The population was evidently breeding successfully, a number of the animals destroyed being females with young near the end of gestation. Several kids a few days old were recorded. On 18th April, when 107 animals were destroyed on the western area, it was estimated that at least three-eighths were adult males.

The few skeletons found were insufficient to indicate any abnormally great number of recent deaths.

Colour of coat was particularly variable, ranging from black and brown to white. Combination of white and brown, and of white, brown and black, were of frequent occurrence.

Mr. L. C. Bell informs me that the animals were much smaller than those naturalised on the mainland. A young male and an adult female which I measured were 3 feet 9 inches in total length from nose to tip of tail; and the length of each horn $6\frac{1}{2}$ inches. Mr. Bell examined several larger specimens, the greatest spread of horns which he recorded being 14 inches.

## ACKNOWLEDGMENTS.

I wish to express my appreciation of the help which I received in the field from the leader of the Expedition, Mr. L. C. Bell, Field Officer, Wild Life Branch, Department of Internal Affairs; and from the other members of the party, Messrs. M. and B. Chaney and B. Meachen. Thanks are also due to Captain Cole and members of the crew of the "New Golden Hind," who succeeded under particularly stormy conditions in re-embarking the party without loss to the valuable collections made on the island.

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### GRASSES.

*Zoisia matrella* (L.) Merrill
*Deyeuxia crinita* (L.) Zotov

### HERBS.

*Oxalis corniculata* L.
*Centella asiatica* (L.) Urban
*Gnaphalium collinum* Lab.

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Subdivisions are two metres square.

Fig. 21.

DISTRIBUTION OF HERBACEOUS SPECIES FORMING GROUND LAYER. Only species regarded as physiognomic are indicated.

—*Carex testacea*; with *Carex virgata* scattered throughout (Sedges).

—*Dichondra repens*.

—*Doodia media*.

—*Oplismenus undulatifolius*, generally in association with *Echinopogon ovatus* (Grasses).

—*Pteris comans*.

—*Scirpus nodosus* (Sedge).

—Patches of turf, consisting of mosses; *Echinopogon ovatus* and other grasses; and less abundantly the herbs *Oxalis corniculata*, *Centella asiatica* and *Gnaphalium collinum*.

Arrows A-F indicate angle of photographs (Figs. 3 to 8), which are intended to be examined in conjunction with charts. Position and angle of photographs are approximate.

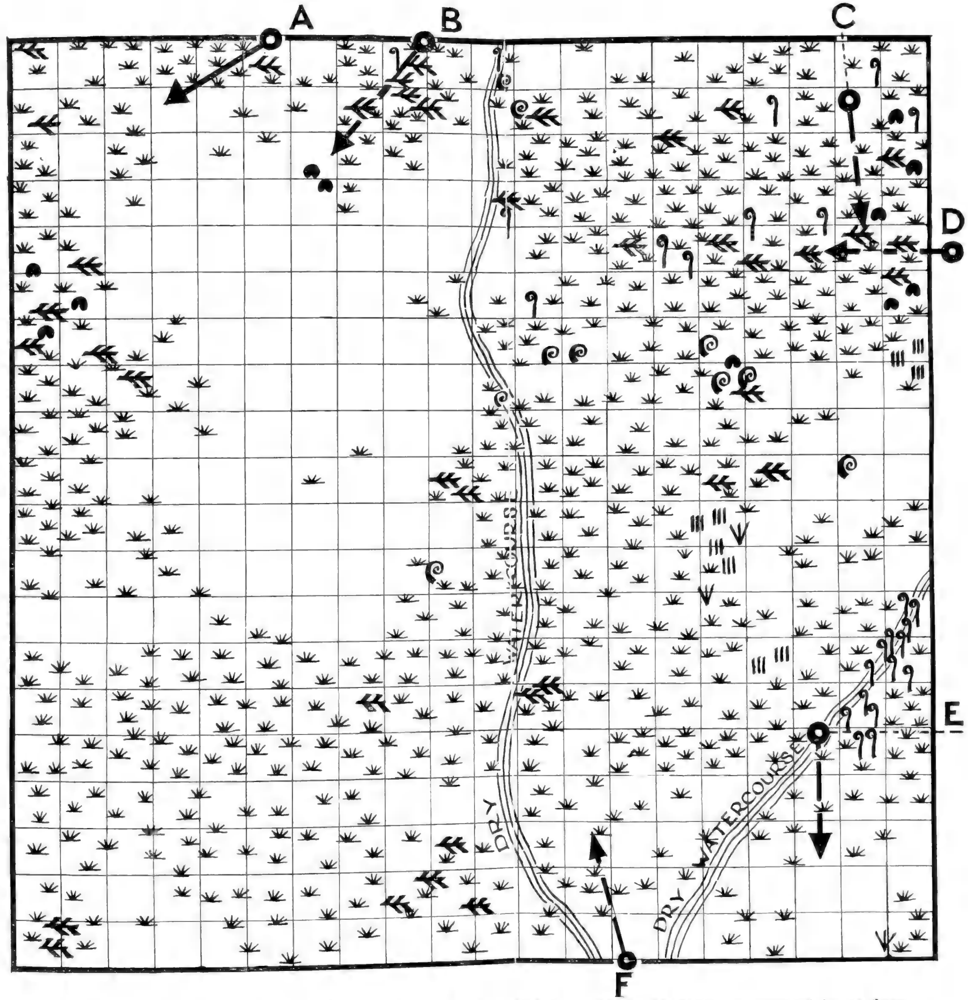


Fig. 21. PLAN OF QUADRAT 1, charted 26th April to 14th May, 1946. Herbaceous plants of forest floor.

Dr. G. T. S. Baylis has kindly identified my plant material from the quadrats, and discussed this paper helpfully at all stages; he has permitted me to refer in some detail to the manuscript of his paper on the vegetation.

Dr. H. H. Allan has kindly identified specimens of lichens, and Mr. G. O. K. Sainsbury of mosses.

I am grateful to Mr. A. W. B. Powell, Dr. W. R. B. Oliver and Major G. A. Buddle for permission to refer to their manuscripts, and to Dr. K. A. Wodzicki for allowing me to examine the manuscript of his report. In the discussion of birds of the island, reference has been made to the manuscript of my joint paper with Major Buddle.

I am indebted to Mr. P. C. Bull for permitting me to compare my observations on relative populations of bird species with his estimates made during the Auckland Museum Expedition in H.M.N.Z.S. "Arbutus" (November-December, 1945).

Finally, I have received valuable assistance from Miss B. E. G. Molesworth and Mr. R. C. Cooper, of Auckland Museum, in botanical aspects of this study.

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## APPENDIX

The vegetation of Great Island has been examined subsequently during visits to the Three Kings in January, 1947, and again in December, 1947-January, 1948, in Major M. E. Johnson's yacht "Rosemary" (Baylis, 1948; Buddle, 1948). On 31st December, 1947, and 1st January, 1948, Dr. G. T. S. Baylis spent a few hours ashore, and was able to re-examine briefly Quadrat III.

I am indebted to Dr. Baylis for his photograph (Fig. 19) and for the following information on this quadrat.

On the sward, grasses still have the low-growing habit but have grown freely, producing abundant seed heads. *Zoisia matrella* is still dominant, but *Deyeuxia crinita*, *Aira praecox* and *Aira caryophyllea* L. occur in some quantity. *Gnaphalium collinum* forms considerable patches.

Adjacent to the northern clump of *Leptospermum ericoides*, seedlings of this species are scattered plentifully, being at present an inch or two above the level of the *Zoisia*. It would appear that in the presence of goats, any seedlings of *Leptospermum ericoides* appearing on the sward had been suppressed by close grazing, and to some degree by trampling. On the forest floor the more selective feeding habits of the goats, and probably shelter provided by the ground layer, would appear to have been effective in enabling seedlings of this species to grow freely.

Changes in the vegetation up to 1st January, 1948, are discussed by Baylis (1948) in an appendix to his paper.

The quadrats have been examined more recently by the writer, with the assistance of Mr. L. C. Bell, during a brief visit on 6th October, 1948. Results of this visit will appear in a future paper.

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Fig. 22.

PLAN DIAGRAM OF QUADRAT II, 26th April to 14th May, 1946. The quadrat is uniformly covered by crowns of mature *Leptospermum ericoides* which are not plotted.

A. WOODY PLANTS OTHER THAN MATURE *LEPTOSPERMUM ERICOIDES.*

—*Cordyline australis.*

—Group of young *Leptospermum ericoides.*

—*Melicope ternata* (2 feet high).

—*Myoporum laetum*—young plant (outside the quadrat).

NOTE: *Coprosma rhamnoides* not plotted (see description in text).

B. GROUND LAYER: general distribution.

—*Carex testacea;* mingled with *Carex virgata* in south corner.

—*Scirpus nodosus.*

A turf, consisting of mosses, grasses and herbs as listed in the text, increases in amount from south to north, becoming practically continuous over the north-east portion.

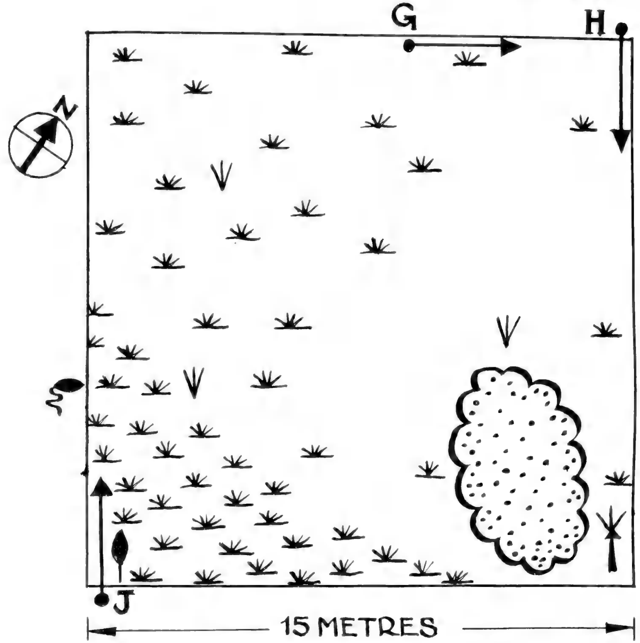



Fig. 23.

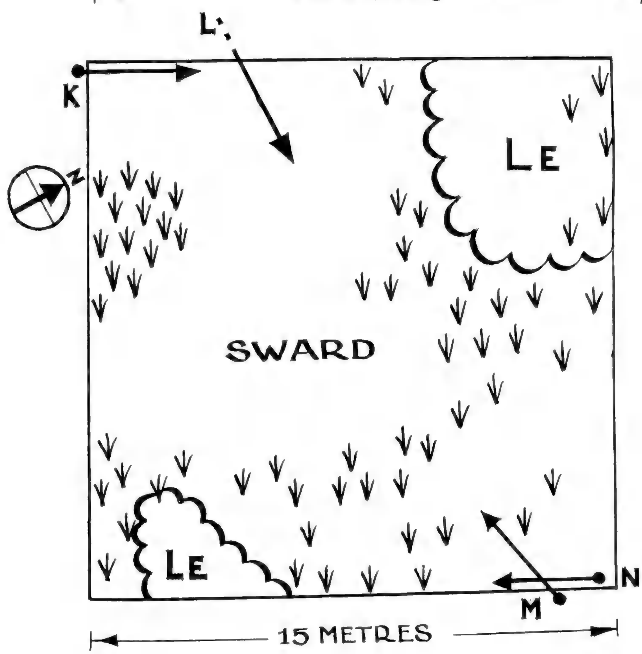
PLAN DIAGRAM OF QUADRAT III, 26th April to 14th May, 1946. Except for areas indicated, the quadrat is uniformly covered by sward composed of lichens, mosses, grasses and herbs listed in the text.

LE —Patches of *Leptospermum ericoides,* low and wind-swept.

—*Scirpus nodosus.*

See also text for list of species growing beneath patches of *Leptospermum ericoides.*

Arrows G-N indicate approximate position and angle of photographs (Figs. 9 to 14, and 18).



# Land Mollusca of the Three Kings Islands

By A. W. B. POWELL, Assistant Director.

In 1935 I published a short paper on the land mollusca of Great Island, based upon a collection made during the "Will Watch" Expedition of February, 1934.

The present paper is descriptive of material from several subsequent sources—my own collecting during the "Arbutus" Expedition, November-December, 1945; Mr. E. G. Turbott's collecting, "Internal Affairs" Expedition, April-May, 1946; and the results of two expeditions in the keel yacht "Rosemary," January, 1947, and January, 1948, respectively, organised by Major M. E. Johnson and Major G. A. Buddle.

The last-mentioned gentlemen succeeded in making small collections on both North East Island, previously considered inaccessible, and South West Island, which had not been investigated since the late Mr. T. F. Cheeseman's brief visit in 1889. Further investigation is required before the land molluscan fauna of the entire group is made known, especially on the difficult West Island, upon which a landing has not yet been made. Great Island has been fairly thoroughly searched, and a bag of leaf-mould obtained by Major Buddle shows that North East Island has a rich micro-fauna, but on South West Island only one snail, a giant new species of *Rhytida,* was found.

A point of interest is that few of the small snails are common to both North East Island and Great Island, yet the comparatively large *Allodiscus cassandra* and the giant *Placostylus bollonsi* are found on both these islands. A probable explanation for the presence of the latter on North East Island is offered in the systematic section which follows.

Only one of the species in the following list is common to the mainland.* (See appendix at end of this paper.)

*Murdochia solitaria* Powell, 1935, Great Island.
*Murdochia filicosta* n. sp., North East Island.
*Murdochia annectens* n. sp., Great Island.
*Allodiscus cassandra* (Hutton, 1883), Great Island; North East Island.
*Allodiscus turbotti* n. sp., Great Island; North East Island.
*Therasiella pectinifera* (Powell, 1935), Great Island; North East Island.
*Egestula gaza* (Suter, 1909), Great Island.
*Mocella manawatawhia* Powell, 1935, Great Island; North East Island.
*Laoma labyrinthica* n. sp., Great Island.
*Phrixgnathus subariel* n. sp., North East Island.
*Laomarex sericea* n. sp., North East Island.
*Paralaoma regia* n. sp., North East Island.
*Paralaoma turbotti* n. sp., Great Island.
*Rhytida (Rhytidarex) johnsoni* n. sp., North East Island.
*Rhytida (Rhytidarex) buddlei* n. sp., South West Island.
*Placostylus (Basileostylus) bollonsi* (Suter, 1908), Great Island; North East Island.
*Placostylus (B.) bollonsi caperatus* n. subsp., Great Island.
*Placostylus (B.) bollonsi arbutus* n. subsp., Great Island.
**Tornatellinops novoseelandica* (Pfeiffer, 1853), North East Island.

## CYCLOPHORIDAE

### Genus MURDOCHIA Ancey, 1901.

**Murdochia solitaria** Powell, 1935.

1935—*Murdochia solitaria* Powell, Proc. Malac Soc. 21 (4), p. 244, Pl. 26, figs. 1 and 2.

*Localities:* Great Island, one dead shell in leaf mould, 150 yards up valley to the S.W. of the provision depôt (A.W.B.P., "Will Watch" Expedition, Feb., 1934) (Holotype); Great Island, ½ mile N.E. from S.E. landing on underside of decaying wood in leaf mould, kanuka (*Leptospermum*) scrub; 1 live adult, larger than the holotype (A.W.B.P., "Arbutus" Expedition, Nov.-Dec., 1945).

Height, 2.2 mm.; diameter, 2.3 mm. (Holotype).
Height, 3.1 mm.; diameter, 3.1 mm. (1945 example).
*Holotype:* In Auckland Museum.

The 1945 example is pale reddish-brown with a buff spiral band at the periphery. This species has a much wider umbilicus than in either of the two following species.

**Murdochia filicosta** n. sp. Pl. 53, fig. 4.

Shell small, acutely conical with lightly convex whorls and subangulate periphery, narrowly umbilicate and sculptured with dense oblique membranous axial threads. Whorls 6, including a small papillate protoconch of two smooth whorls. Spire about twice height of aperture. Post-nuclear sculpture of dense retractively oblique threads, about 55 on the body-whorl. Umbilicus a narrow chink partially obscured by the reflexed columellar lip. Aperture subcircular, connected across parietal wall by a thin callus. Colour very dark brown, almost black. Worn and partially bleached examples exhibit spiral colour bands in dark brown on a paler ground—a broad band occupying the lower half of the spire whorls, a narrower one on the base, emergent from the suture, and another encircling the umbilical area.

Height, 4.2 mm.; diameter, 2.9 mm. (Holotype).
*Locality:* North East Island in leaf mould, common (G. A. Buddle, Jan., 1948).
*Holotype:* In Auckland Museum.

**Murdochia annectens** n. sp. Pl. 53, fig 3.

Very similar to *filicosta* but broadly conical, with a lower spire, more definitely angled at the periphery and with more distant axial threads. Whorls 5½, including a small papillate protoconch of two smooth whorls. Spire about 1¼ times height of aperture. Post-nuclear sculpture of numerous retractively oblique membranous axial threads, about fifty on the body-whorl. The axials are more widely spaced than in *filicosta* owing to the greater width of the shell. Umbilicus a narrow, oblique chink. Colour pale yellowish-brown with two broad chestnut bands upon the base.

Height, 4.3 mm; diameter, 3.4 mm. (Holotype).
*Locality:* Great Island, ½ mile N.E. from S.E. landing, on under side of decaying wood in leaf mould, kanuka (*Leptospermum*) scrub; 1 live example.
*Holotype:* In Auckland Museum.

The species is more closely allied to the North East Island *filicosta* than to *solitaria*, with which it was found.

## FLAMMULINIDAE

### Genus **ALLODISCUS** Pilsbry, 1892.

Type (s.d. Pilsbry, 1894): *Helix dimorpha* Pfeiffer.

**Allodiscus cassandra (Hutton, 1883).**

1883—*Charopa? cassandra* Hutton, N.Z. Jour. Sci. 1, p. 476.

1913—*Allodiscus cassandra:* Suter Man. N.Z. Moll., p. 637.

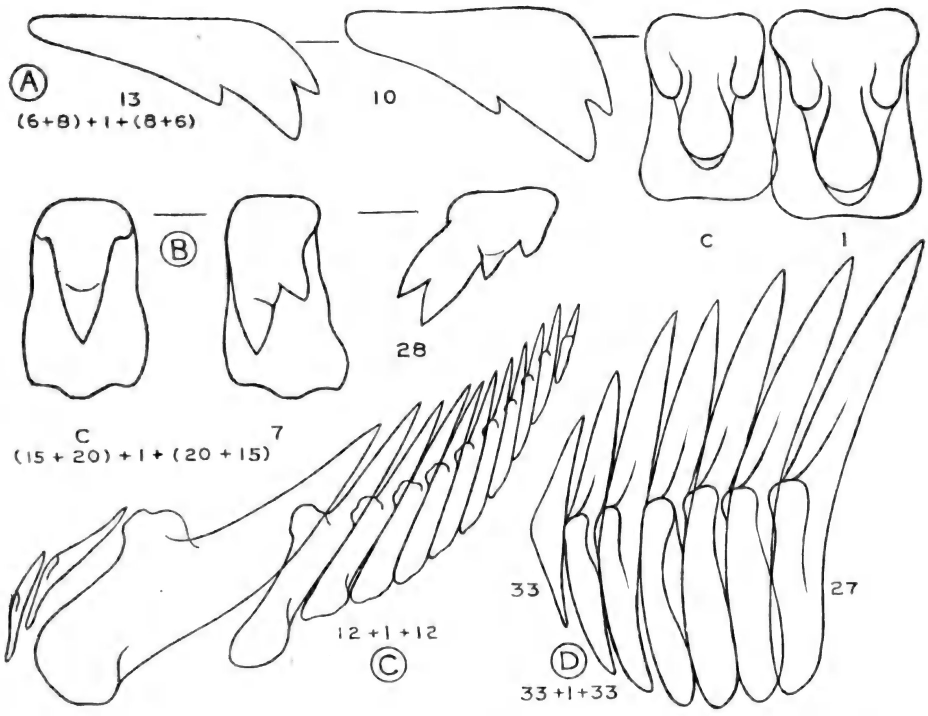
1935—*Allodiscus cassandra:* Powell Proc. Malac. Soc. 21 (4), p. 245.

*Localities:* Great Island, valley to S.W. of provision depot in leaf mould from around roots of *Carex* (A.W.B.P., "Will Watch" Expedition, Feb., 1934); Great Island, N.E. end of island (A.W.B.P., Nov.-Dec., 1945), S.W. side of island (E. G. Turbott, April, 1946); North East Island (G. A. Buddle, Jan., 1948).

*Holotype:* Canterbury Museum, Christchurch.

*Dentition:* (15 + 20) + 1 + (20 + 15) (Description, Powell, 1935, p. 245). Text fig. B.

This species and *Egestula gaza* are the only generally distributed common land molluscs on Great Island. They have adapted themselves to the induced monotony of kanuka scrub. They are found on and within rotting wood wherever mould provides sufficient food, for mostly there are no large leaved trees in the areas where these snails flourish.




Text fig. A. *Egestula gaza*, central tooth, first lateral and Nos. 10 and 13 from centre. B. *Allodiscus cassandra*, central tooth and Nos. 7 and 28 from centre. C. *Rhytida greenwoodi*, central to outermost lateral. D. *Rhytida (Rhytidarex) johnsoni*, laterals 27-33 from centre.

**Allodiscus turbotti** n. sp. Pl. 53, fig 1.

Shell globose, multicostate, umbilicate, pale-brown with a complicated pattern of radial bars, spots and chevrons. Whorls tightly coiled, $5\frac{1}{2}$, including a low, convex protoconch of $1\frac{1}{2}$ whorls, all but the nucleus sculptured with closely-spaced thin radials. Spire about two-thirds height of aperture. Post-nuclear sculpture of dense narrow radials, 42 on the first whorl, 85 on the penultimate and about 150 on the body-whorl. Interstices with from 4 to 10 exceedingly fine crisp radial threads. Radials flexuous, slightly protractive from suture and noticeably retractive before entering the umbilicus. Umbilicus open, one-tenth major diameter, deep, cylindrical, and slightly bridged by the reflexed inner lip. The base flattens somewhat towards the umbilicus and then resolves into a narrowly rounded encircling rim. Aperture lunate; peristome thin and flexuous, slightly protractive above, broadly rounded medially and deeply insinuated at the junction between the basal and inner sections of the lip. Suture deeply impressed, almost channelled. Colour pale brown with a chestnut colour pattern composed of irregular radially disposed rectangular patches at the suture which resolve into spots, and streaks of chevron form over the rest of the shell, base included. Major diameter, 5.7 mm.; minimum diameter, 5.1 mm.; height, 4.15 mm.

*Locality:* Great Island, north-east of Hakupu Point in sparse pohutukawa and kanuka forest (E. G. Turbott, 8/5/1946) (Holotype); North East Island, in leaf mould (G. A. Buddle, Jan., 1948) (one dead shell).

The species resembles *cassandra* in having a radially costate protoconch, but is of much smaller adult size, is openly umbilicate, and has more numerous and stronger radial ribs. In *cassandra* there is no umbilicus at any growth stage. The animal is unknown, but location in *Allodiscus* is almost certain from the style of sculpture and form of the aperture.

## Genus **THERASIELLA** n. gen.

Type: *Nanina* (?) *celinde* Gray.

Inclusion of the small, depressed, acutely angulate *Phrixgnathus*-like *celinde* and *tamora* in *Therasia* is incongruous. The genus *Therasia* should be restricted to the larger, subglobose species centred around the genotype *thaisa*. Features of *Therasiella*, quite foreign in *Therasia*, are the presence of membranously plaited epidermal processes, and the small number of teeth in the radula (18 + 1 + 18), the marginals of which are bicuspid. In *thaisa* the formula is 26 to 28 + 1 + 28 to 26, and the marginals of this species and the associated *decidua*, *traversi* and *valeria* have from three to five cutting points.

**Therasiella pectinifera** Powell, 1935.

1935—*Therasia pectinifera* Powell Proc. Malac. Soc. 21 (4), p. 245.

*Localities:* Great Island, 150 yards up valley to the S.W. of the provision depot, in leaf mould (A.W.B.P., "Will Watch" Expedition, Feb., 1934); Great Island, N.E. end of island (A.W.B.P., Nov.-Dec, 1945); North East Island (G. A. Buddle, Jan., 1948). Not common.

*Holotype:* In Auckland Museum.

## CHAROPIDAE

### Genus **EGESTULA** Iredale, 1915.

Type (o.d.): *Helix egesta* Gray.

**Egestula gaza** (Suter, 1909).

1909—*Endodonta (Charopa) gaza* Suter Proc. Malac. Soc. 8, p. 260.

1913—*Endodonta (Charopa) gaza:* Suter Man. N.Z. Moll., p. 711.

1915—*Egestula gaza:* Iredale Trans. N.Z. Inst. 47, p. 482.

1935—*Egestula gaza:* Powell Proc. Malac. Soc. 21 (4), p. 246.

*Locality:* Great Island.

*Holotype:* In Suter collection, N.Z. Geological Survey, Wellington.

This species is very abundant in all parts of Great Island where there is sufficient cover. Even in the rather dry areas of kanuka it is commonly found on the ground on the under side of decaying twigs and branches. It is evidently absent from North East Island.

There are two colour forms, one uniformly ochreous-brown and the other, which is less common, with the addition of broad reddish-brown radial streaks.

*Dentition:* $(6 + 8) + 1 + (8 + 6)$ (Text fig. A). Study of the radula confirms Iredale's action (1915 l.c.) in associating the species with *egesta,* type of his genus *Egestula.* Both species differ from other Endodont genera in having low marginals with a very wide base, obliquely produced on the distal side. The formula for *egesta* is $9 + 5 + 1 + 5 + 9$.

### Genus **MOCELLA** Iredale, 1915.

Type (o.d.): *Helix corniculum* Reeve.

**Mocella manawatawhia** Powell, 1935.

1935—*Mocella manawatawhia* Powell, Proc. Malac. Soc. 21 (4), p. 246.

*Localities:* Great Island, 150 yards up the valley to the S.W. of the provision depot in leaf mould (type) (A.W.B.P., "Will Watch" Expedition, Feb., 1934); Great Island (E. G. Turbott, 4/5/1946); North East Island in leaf mould (G. A. Buddle, Jan., 1948). Very scarce.

*Holotype:* In Auckland Museum.

## LAOMIDAE

### Genus **LAOMA** Gray, 1849.

Type: *Bulimus? (Laoma) leimonias* Gray.

**Laoma labyrinthica** n. sp. Pl. 54, fig. 3.

Shell very small, trochiform, carinated, narrowly perforated, regularly and closely radially ribbed, subtranslucent white, radially streaked with broad patches of reddish brown; aperture with massive lamellate processes. Whorls five, including a smooth protoconch of $1\frac{1}{2}$ whorls. Post-nuclear whorls sculptured with distinct, rounded, slightly retractively arcuate radials (about 80 on penultimate and over 100 on the body-whorl), equally well developed on both dorsal and ventral surfaces, but interrupted at the acutely angled periphery by a sharply raised rounded

supra-sutural carina. Spire broadly conical, convex sided, about one and a-third times height of aperture. Aperture rhomboidal with thin discontinuous peristome, strengthened within by massive lamellate processes—one on the columella, two on the parietal wall, two within the outer lip above the carina, the uppermost very weak, and two on the basal lip. The most massive members are the columellar one and the proximal of the pair within the basal lip. The two within the outer lip are the least developed. The main processes are so large that they almost bridge the aperture.

Diameter, 2.35 mm.; height, 1.5 mm. (holotype).

*Locality:* Great Island, ½ mile N.E. from S.E. landing on under side of decaying wood in leaf mould, kanuka (*Leptospermum*) scrub (A.W.B.P., Dec., 1945). One adult only.

*Holotype:* In Auckland Museum.

The species is nearest allied to *marina* Hutton, 1883, from which it differs in its much smaller size, more distant and definite radial ribs, conspicuous colour pattern and massive development of the apertural processes.

## Genus **Phrixgnathus** Hutton, 1883.

Type (o.d.): *Helix fatua* Hutton, 1882, not of Pfeiffer.

= *Phrixgnathus celia* Hutton, 1883.

### **Phrixgnathus subariel** n. sp: Pl. 54, fig. 4.

Shell small, depressed-turbinate, subperforate, thin, angulate, corneous, with regular fairly straight reddish-brown radial streaks. Whorls 4½, including a low smooth protoconch of 1½ whorls. Periphery weakly angulate. Spire depressed dome-shaped, equal to height of aperture. Post-nuclear sculpture of dense, weak, somewhat irregular radial ribs on the dorsal surface and closely spaced distinct spiral striations on the base. Radial colour streaks extending over all whorls from suture to the umbilicus, evenly retractively arcuate on the spire whorls and slightly flexuous on the base. Reflexed columella lip almost obscuring a tiny umbilical cavity.

Diameter: 2.8 mm.; height, 1.9 mm. (holotype).

*Locality:* North East Island, in leaf mould (G. A. Buddle, Jan., 1948).

*Holotype* and paratypes in Auckland Museum.

The species is nearest to *ariel* Hutton, which has a slightly taller spire, less conspicuous basal striations, and the colour streaks arranged in a vigorous zigzag pattern.

## Genus **LAOMAREX** n. gen.

Type: *Laomarex sericea* n. sp.

This genus is provided for a species which, although it resembles *Phrixgnathus* in form, lacks the translucent texture of that genus. It has the addition of dense membranous radials reminiscent of *Therasiella*

nov. (described in this paper) and a strongly sculptured protoconch of beaded spirals. At first appearance the genus appears to be *Therasiella,* particularly on account of the dark brown membranous radials, but the protoconch is low and sculptured, not exsert, and smooth or practically smooth. The presence of an underlying radiate colour pattern is another feature foreign to *Therasiella* but common to the *Laomidae.*

Since no living examples were taken, the exact relationship of the genus still requires to be confirmed.

**Laomarex sericea** n. sp. **Pl 54, fig. 1.**

Shell small, depressed, broadly conical with angulate periphery and deep narrow umbilicus. Spire 1½ times height of aperture, outlines broadly convex. Whorls 6, including a low dome-shaped protoconch of 1½ whorls, distinctly sculptured with twelve dense beaded spirals and followed by a half-whorl of closely spaced radials. Post-nuclear sculpture of extremely dense and fine membranous radials, over 200 on the penultimate, overlying a surface sculpture of fine dense spiral threads. Dorsal surface and base similarly sculptured. Umbilicus a deep narrow pit. Colour dull brown, showing an obscure pattern of rather wide-spaced reddish-brown radial stripes.

Diameter, 3.25 mm.; height, 2.00 mm. (holotype).

*Locality:* North East Island, in leaf mould (G. A. Buddle, Jan., 1948).
*Holotype* and four paratypes in Auckland Museum.

## Genus **PARALAOMA** Iredale, 1913.

Type (o.d.): *Paralaoma raoulensis* Iredale.

**Paralaoma regia** n. sp. **Pl. 53, fig. 2.**

Shell minute, depressed-turbinate, widely umbilicated, finely radially costate, thin, shining, horn coloured. Spire less than half height of aperture. Body-whorl narrowly rounded but not angled; periphery above the middle. Whorls 4¼, regularly and slowly increasing, including practically smooth protoconch of 1½ whorls. On the last half whorl of the protoconch there are exceedingly fine spiral striations. Suture deeply impressed. Post-nuclear sculpture of numerous crisp retractively arcuate radial ribs, about 40 on the penultimate and approximately 50 on the last whorl. Interstices reticulated with microscopic radial threads crossed by numerous spiral lirae. The radial threads number from 2 to 4 per intercostal space. On the base the spiral lirae are stronger than the radial threads, which they cross and render minutely granulate. Umbilicus deep, one-fifth major diameter of the base.

Major diameter, 1.7 mm.; minimum diameter, 1.45 mm.; height, 0.85 m.m. (holotype).

*Locality:* North East Island, in leaf mould (G. A. Buddle, Jan., 1948). Very abundant.

*Holotype* and paratypes in Auckland Museum.

The species is very similar to the Kermadec genotype, *raoulensis,* but is constantly smaller, has more numerous radial ribs (*raoulensis* has about 34 on the penultimate and over 40 on the body-whorl) and the

interstitial spiral lirae of the base dominate the interstitial radials. In *raoulensis* the interstitial radials are stronger than the spirals.

The protoconch in the genotype has weak spiral striations on the last half-whorl, and this same style of nucleus is found in *regia* and *turbotti* n. sps., *Hyalina allochroida lateumbilicata* Suter, 1890 (referred to *Paralaoma* by Iredale, 1915, Trans. N.Z. Inst. 47, p. 482), as well as in *Microphysa* (?) *pumila* Hutton, 1883, the closely allied *Patula raricostata* Suter, 1890, and *Hyalina allochroida* Suter, 1890 (all here referred to *Paralaoma*). Unfortunately the dentition of *raoulensis* is not known to me, but the New Zealand *lateumbilicata* and *pumila* are alike in having a small number of bicuspid lateral-marginal teeth and a tricuspid central tooth (14 + 1 + 14 for *lateumbilicata* and 13 + 1 + 13 for *pumila*). In *leimonias,* the genotype of *Laoma,* the formula is 25 + 1 + 25, consisting of a unicuspid central and bicuspid lateral-marginal teeth. In *celia,* the genotype of *Phrixgnathus,* the formula is 20 + 1 + 20, consisting likewise of a unicuspid central and bicuspid lateral-marginals. The *Phrixgnathus* species *ariel, conella, cheesemani, glabriuscula, marginata* and *phrynia* have teeth of similar style to those of the genotype *celia,* and the numerical formulae range between 26 + 1 + 26 and 40 + 1 + 40.

**Paralaoma turbotti** n. sp. Pl. 54, fig. 2.

Shell minute, depressed-turbinate, narrowly umbilicated, closely radially costate, microscopically densely spirally striate, thin, shining, uniformly light brown. Spire slightly taller than height of aperture. Suture deeply impressed. Whorls 4½, slowly increasing, including a low rounded protoconch of 1½ microscopically spirally striated whorls. Post-nuclear sculpture of numerous somewhat irregular rounded radial ribs, stronger on dorsal surface; about 60 on the penultimate and approximately 90 on the body-whorl. The whole surface crowded with dense, microscopic, spiral, linear-spaced lirations, interstial on the dorsal surface but crossing the weakened radials of the base. Umbilicus deep, narrow and straight sided, about one-eighth major diameter of the base. Aperture lunate, with thin outer lip. Inner lip reflexed, partly concealing the umbilicus.

Major dameter, 1.6 mm.; minimum diameter, 1.45 mm.; height, 1.0 mm. (holotype).

*Locality:* Great Island (E. G. Turbott, 4/5/1946); ½ mile N.E. from S.E. landing, Great Island, on under side of decaying wood in leaf mould, kanuka (*Leptospermum*) scrub (A.W.B.P., Dec., 1945).

*Holotype* and two paratypes in Auckland Museum.

This species resembled both *allochroida* Suter and *lateumbilicata* Suter in its depressed turbinate form, style of sculpture and faintly spirally striated protoconch. It differs from both in having a greater number of radial ribs, an umbilicus wider than in *allochroida* and narrower than in *lateumbilicata,* and in being darker in colour.

Suter gave the dimensions of his *allochroida* as 1.5 mm. x 1 mm., which is incorrect, for his largest co-type is only 1.3 mm. One of Suter's three co-types measuring 1.25 mm. x 1.15 mm. x 0.85 mm. has been segregated as a lectotype.

The animals of both *allochroida* and the subspecies *sericata* (Suter, 1890) are unknown and the three dried examples of *turbotti* are unsuitable for anatomical study. These species are placed provisionally in *Paralaoma* rather than in *Phrixgnathus,* for on shell characters they appear to be more in accord with the former.

## PARYPHANTIDAE

### Genus RHYTIDA Albers, 1860.

### Subgenus RHYTIDAREX n. subgen.

Type: *R. (Rhytidarex) johnsoni* n. sp.

Although the North East Island *Rhytida* described below has normal external characteristics, the dentition is quite discordant. In typical *Rhytida* the dental formula ranges between 12 + 0 + 12 for *meesoni* and 18 + 1 + 18 for *dunniae* and *patula.* All have the aculeate laterals gradually increasing in size, until near the margin, where a disproportionately large and massive tooth occurs, followed by from one to five very small teeth. In the new subgenus *Rhytidarex* the formula is 33 + 1 + 33, all the laterals are narrowly aculeate, and there is no disproportionately large member. The laterals increase gradually to number 30 and then rapidly decrease, number 33 being only half the size of 30. Actually the radula of *Rhytidarex* more closely resembles that of *Wainuia,* the formula of which ranges between 14 + 1 + 14 for *urnula* and 26 + 1 + 26 to 27 + 1 + 27 for *edwardi.* The form of the radula in *Wainuia* is very similar to that of *Rhytidarex,* no extra large member, just gradually increasing aculeate laterals to the last but one, the last being half the height of the largest. The thin dark chitinous shell of *Wainuia,* however, is very different in structure from that of *Rhytida,* which is strongly reinforced with lime.

Protoconch similar to that of *greenwoodi,* the genotype of *Rhytida,* but with less distinct radial sculpture.

**Rhytida (Rhytidarex) johnsoni** n. sp. Pl. 55, figs. 10-12.

Shell of moderate size for the genus, thin and depressed, with rapidly increasing whorls. Whorls $3\frac{1}{2}$, including a slightly convex protoconch of $1\frac{1}{2}$ weakly radially wrinkled whorls. Post-nuclear whorls commencing with fairly regular, closely spaced radial wrinkle-striae, but becoming irregularly anastomosing and finally malleate over the latter half of the body-whorl. This sculptural pattern is fine but distinct on the dorsal surface, but obsolescent on the base from just below the periphery. The periphery is narrowly rounded, scarcely carinated. Umbilicus deep, graduate, about one-eighth major diameter of base. Spire about one-third height of shell. Colour of epidermis uniformly pale yellowish olive.

Major diam., 22.0 mm.; min. diam., 17.5 mm.; ht., 11.5 mm. (holotype)
Major diam., 22.0 mm.; min. diam., 17.0 mm.; ht., 11.2 mm. (paratype)
Major diam., 21.6 mm.; min. diam., 17.0 mm.; ht., 11.7 mm. (paratype)

*Animal* narrow, dorsal surface dark smoky grey, with a narrow, light-brown median stripe, clouded with dark grey towards the head. Neck and sides with rather large ovate flattened granules. Edge of foot and sole fawn to pale smoky grey. Tentacles dark grey, finely granulate.

*Radula:* 33 + 1 + 33, described above (text fig. D.).

*Egg:* 5.75 mm. × 4.5 mm. This is larger than for any of the mainland species so far recorded (see O'Connor, 1945, Trans. Roy. Soc. N.Z. 75, p. 54).

*Locality:* North East Island under decaying leaves at the fringe of the large puka grove (*Meryta*) which caps the island, (M. E. Johnson and G. A. Buddle, Jan., 1948).

*Holotype* and paratypes in Auckland Museum.

The species is named in recognition of Major M. Earle Johnson's fine exploration work in the Three Kings Group, especially for his feat of landing upon the previously considered inaccessible North East Island.

**Rhytida (Rhytidarex) buddlei** n. sp. Pl. 55, figs. 8, 9.

Shell very large, larger than any other known species, thin and depressed with rapidly increasing whorls. Whorls 4½, including a protoconch of 1½ whorls (worn in only specimen). Periphery narrowly rounded, scarcely carinated. Umbilicus deep, gradate, one-sixth major diameter of the base. Surface badly worn but showing on the dorsal surface dense radial wrinkle-striae becoming malleated over the later whorls. The base from below the periphery is more or less smooth as in *johnsoni*. Spire about one-third height of shell. Traces of a thin brownish epidermis remain.

Major diameter, 64.0 mm.; minimum diameter, 51.0 mm.; height, 29.0 mm. (holotype).

*Locality:* South West Island, Three Kings Islands, G. A. Buddle and M. E. Johnson, 3rd Jan., 1947. One specimen only picked up from amongst leaves in a large puka grove (*Meryta*) near the crest of the island.

*Holotype:* In Auckland Museum.

Apart from its much greater adult size, this species closely resembles the North East Island *johnsoni*, the only obvious difference being in the manner of the coiling, which is more tightly wound in *buddlei*.

The species is named in recognition of Major G. A. Buddle's excellent work in making natural history collections and observations at the Three Kings group in company with Major M. Earle Johnson.

## PLACOSTYLIDAE

### Genus PLACOSTYLUS Beck, 1837.
### Subgenus BASILEOSTYLUS Haas, 1935.

Type (o.d.) *Placostylus bollonsi* Suter, 1908.

*Placostylus bollonsi* was discovered on Great Island by the late Captain J. Bollons, of the Government Steamer "Hinemoa," in April, 1907.

Mr. H. B. Williams, formerly second officer on the Government Steamer "Matai," who was present when the species was discovered, stated that it occurred in a small karaka grove (*Corynocarpus laevigata*) near a large overhanging rock on the S.E. landing slope, below the provision depot.

In 1920 Captain Bollons informed the writer that only about fifty specimens, inclusive of old shells, had been found, and that in his opinion the species had become extinct.

In December, 1928, an empty shell was picked up in "tussock" on the S.E. landing slope by Lady Alice Fergusson, but no living examples were found (Fraser, 1929, N.Z. Journ. Sci. and Tech. 11 (3), p. 154).

During the "Will Watch" Expedition, February, 1934, a determined search was made during two half days on the island, but no trace of the species was found apart from a fragment picked up by Mr. C. A. Fleming on the N.W. landing slope (Powell, 1935, Proc. Malac. Soc. 21, p. 247).

The following account describes the finding of four living colonies and one recently exterminated, all additional to the original locality.

**1. Great Island, S.E. landing slope.** Type locality; in small karaka grove near a large overhanging rock on the S.E. landing slope, Great Island. The vegetation on this slope has been greatly altered by the depredations of goats (recently exterminated). There is no trace of the original karaka grove, only *Carex* and rather sparse kanuka (*Leptospermum ericoides*). No evidence of *Placostylus* remains was found, but it was here that Lady Alice Fergusson picked up an empty shell in 1928. The type colony is undoubtedly extinct.

**2. Great Island, N.E. colony.** Situated at about 500 feet elevation, above the level of the Provision Depot and about half a mile north-east from it, on the lower side of a long, rocky cliff-face in moderately dense scrub. The colony consisted apparently of only eleven snails (all adults) and was restricted to the leaf spread area afforded by a group of seven trees of wharangi (*Melicope ternata*) and one of mahoe (*Melicytus ramiflorus*). The area occupied by the colony was not more than 5 to 10 feet wide and 30 feet long, on a slope of about 45°.

Very large boulders through the area made it impossible to be certain that the entire colony was counted. Two complete but old eggs were found and some dead juveniles.

Colony located by the writer during eight days on the island—"Arbutus" Expedition, November-December, 1945.

**3. North East Island colony.** North East Island is separated by a narrow waterway from the N.E. end of Great Island. In contrast with the greatly altered vegetation and semi-arid condition of Great Island, North East Island is covered with luxuriant vegetation dominated by a large grove of puka (*Meryta sinclairii*). In January, 1947, Messrs. G. A. Buddle and M. E. Johnson landed on this almost inaccessible island and found *Placostylus* in abundance over most of the island. A series of living examples and ten complete but old eggs were taken.

**4. Great Island, N.W. landing slope.** In stunted ngaio scrub, at about 500 feet elevation on the N.W. slope above the landing and about 500 yards west of the saddle. Some 40 living examples were observed by Mr. E. G. Turbott in April, 1946, and about 200 dead shells were taken. The colony was discovered by Mr. L. C. Bell.

**5. Great Island, S.W. colony.** In a small hanging valley near the foot of a boulder scree at about 700 feet elevation on the seaward slope of the western side of the island, just south of Crater Head. The snails were found in a deep accumulation of leaves amongst boulders in a grove consisting of mahoe, *Melicytus ramiflorus* (2), wharangi, *Melicope ternata* (2), puriri, *Vitex lucens* (1), *Sideroxylon costatum* (1), and *Olea apetala* (1). Adjoining was a group of large *Brachyglottis* n. sp. (14) (see Oliver, p. 236) and pohutukawa *Metrosideros tomentosa* (1). The colony was concentrated in the first grove, but one example was found under the *Brachyglottis* and this was observed eating dead leaves of this tree. Twenty-five snails were counted, nearly all adults, but owing to the numerous inaccessible crevices between boulders there could be more than double this number present. The colony was discovered by Messrs. R. Wilson and G. A. Buddle, "Arbutus" Expedition, November-December, 1945.

**6. Great Island, Hapuku Point colony.** Several hundred yards east of Hapuku Point on steep boulder scree in sparse forest consisting mainly of large pohutukawa and kanuka. The undergrowth had been eaten out by goats and the ground trampled and rendered too dry for living snails. A number of weathered dead shells were collected by Mr. E. G. Turbott in April, 1946.

Following are detailed measurements of ten examples from each of the six known colonies of *bollonsi.*

The average figures given at the end show that there are two groups: (A) shells with a height of two and one-third times that of the aperture and (B) shells with a height of two and a-half times that of the aperture.

Group A colonies (localities 1, 2 and 3) have an average height of between 91.65 mm. and 95.67 mm., but Group B colonies subdivide into B1, a small-sized race (locality 4) with an average height of 90.20 mm., and B2, a large-sized race (localities 5 and 6) with average heights of 108.40 mm. and 97.85 mm. respectively.

These groups are located as follows: A. *Typical* (localities 1, 2 and 3), north-east end of Great Island and North East Island. B1. north-west landing slope, and B2 S.W. side of Great Island.

The presence of three different forms of *bollonsi* on one comparatively small island requires some explanation, especially as the form from the neighbouring North East Island is not a distinct one but is identical, or almost identical, with one of the Great Island forms.

There are several possible explanations for this. Firstly, the state of the vegetation just prior to the removal of the goats in 1946 was very adverse to the existence of these snails on Great Island. They were restricted to a very few small areas of their succulent food plants in a widespread expanse of kanuka (*Leptospermum*) scrub. Each colony was small and completely isolated from the others by the general cover of kanuka scrub, which apparently does not provide suitable food for these large herbivorous snails.

PLATE 53.

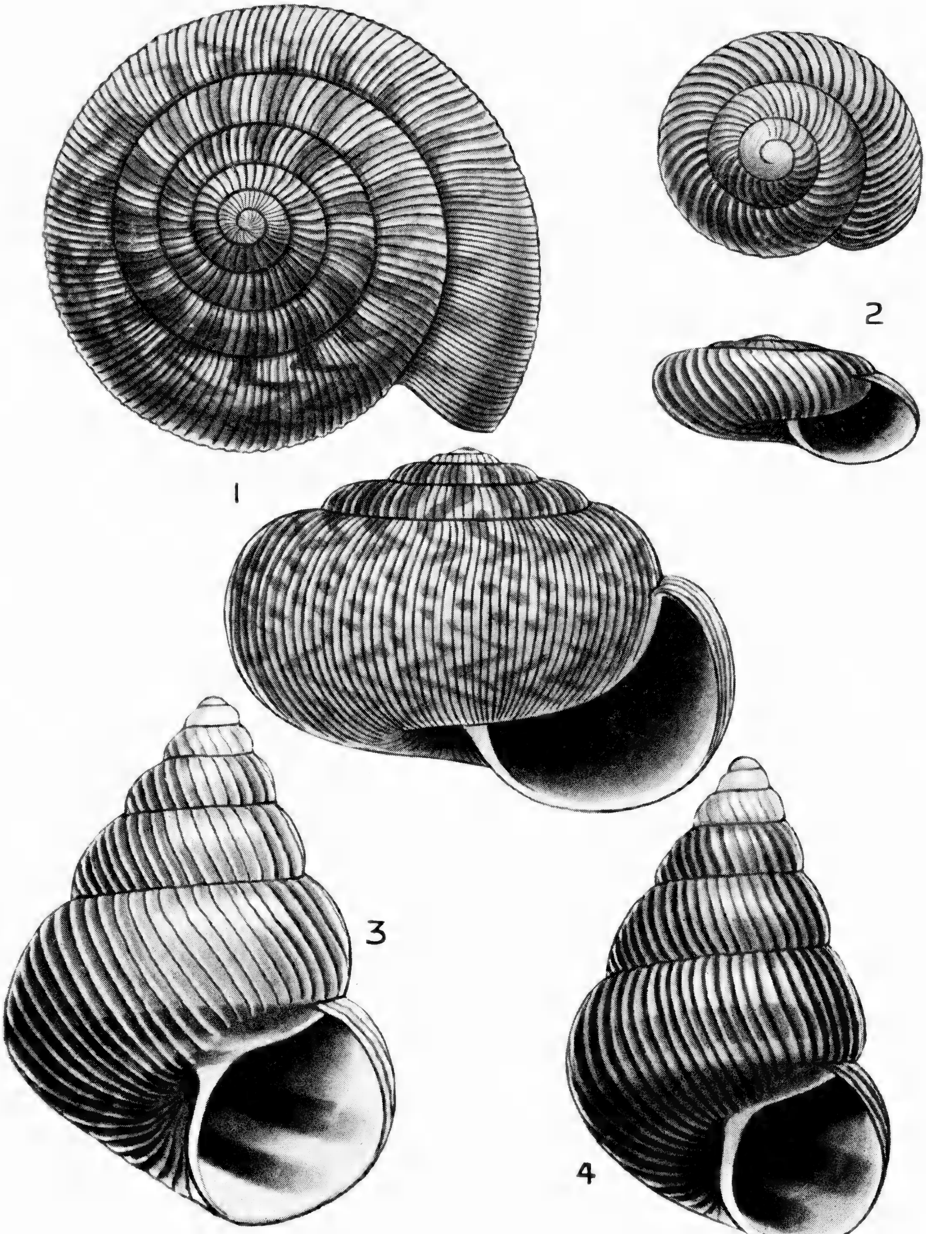



Fig. 1. *Allodiscus turbotti* n. sp., 4.15 mm. x 5.7 mm. Great Id. Holotype.

Fig. 2. *Paralaoma regia* n. sp., 0.85 mm. x 1.7 mm. North East Id. Holotype.

Fig. 3. *Murdochia annectens* n. sp., 4.3 mm. x 3.4 mm. Great Id. Holotype.

Fig. 4. *Murdochia filicosta* n. sp., 4.2 mm. x 2.9 mm. North East Id. Holotype.

It is at once apparent that the vegetation on Great Island has been greatly modified. In spite of its being well watered, Great Island is the one semi-arid member of the four larger islands comprising the group. There can be little doubt that Great Island once resembled these other islands, where the puka (*Meryta sinclairii*) is a dominant feature.

Coupled with the depredations made by the goats must be added the prior human factor of at least three centuries of occupation by Maoris.

At the time of Tasman's discovery of the islands in 1643, Maoris were in occupation; and Tasman noted in his journal that most of the more accessible parts were under cultivation. This was probably an important factor in reducing the snail populations to the perimeter of more or less inaccessible cliff faces. It is significant that the existing snail colonies are on steep, rocky slopes, which do not show signs of Maori occupation. The presence of rocky screes at each of the localities where *bollonsi* still persists shows that rough ground conditions have been the prime factor in the preservation of these colonies from extinction. These rocky screes have allowed an accumulation of leaves in their interstices, tended to conserve moisture, and above all have prevented trampling by goats. Several likely looking groves of large-leaved trees not on rocky ground proved negative for snails owing to the almost complete removal of undergrowth by the browsing goats.

Some factor earlier than the human one must have operated, however, as shown by the present occurrence of group A and B snails respectively, the former on the north-eastern portion of the hour-glass shaped shaped Great Island, and the later on the south-western portion. The narrow neck or saddle in question may have been a former waterway dividing Great Island into two islands, but more likely the presence of nesting colonies of gulls and petrels on this neck has long maintained ground conditions impassable to the snails.

There remains the difficult explanation of why the North East Island snails are so nearly identical with those from the N.E. end of Great Island. The waterway separating North East Island is deep and evidently of considerable age, so human agency is the most likely explanation. Messrs. Buddle and Johnson found much evidence of former Maori occupation on North East Island, which was evidently used as a kitchen garden, for there are the remains of extensive stone contour walls, built to prevent the soil from washing down the steep slopes. Similar walls occur on Great Island.

The assumption is that these snails were either intentionally or unintentionally introduced to North East Island from the north-eastern end of Great Island. Young *Placostylus* could easily have been accidentally transported with plants taken by the Maoris for replanting on North East Island.

It is of note that Mr. A. C. O'Connor found living young *Placostylus hongii* in *Astelia* clumps situated 8 to 10 feet from the ground on puriri limbs at Whangaruru.

The existence of several well-marked subspecies of *Placostylus* on a small island is paralleled by an example at Lord Howe Island, where at least three recent forms and a fossil one are found within the confines of an island less than seven miles long and about a mile wide.* One of these, *Placostylus bivaricosus etheridgei* (Brazier) is larger, thinner and more elongated than the typical species. It lives high up under the wall of Mt. Lidgbird, just as its parallel on Great Island (No. 5 colony) shows similar shell-divergence from the typical form and occupies a similar location.

Whatever the reason may be for the divergence in form of the *bollonsi* colonies as at preesnt segregated, there seems to be justification for giving nomenclatural status to the three forms as subspecies brought about by isolating factors.

Objection may be raised to my action in giving names to subspecies that possibly owe their origin to either human or to ecological agency. On the other hand, the giving of nomenclatural status to these variant colonies will help to keep the problem in view, inasmuch as that the validity of the names will doubtless come up for consideration from time to time in the future, and may lead to further field investigation.

Now that the goats have been eliminated the Great Island vegetation will have a chance to recover and in the course of time may provide sufficient continuity of succulent, large-leaved vegetation to enable the spread and intermingling of the now segregated *Placostylus* colonies. In 25, 50 or more years' time a re-survey of the *bollonsi* colonies should yield useful information on the species problem.

## TABLES OF DIMENSIONS.

### A.—Adult shells from six BOLLONSI colonies.

1. Great Island, S.E. landing slope (type locality).

| Ht. | Diam. | Ap. ht. | Sp. ratio. | Sp. ang. |
|---|---|---|---|---|
| 97.00 mm. | 39.00 mm. | 42.00 mm. | 2.31 | 38° |
| 95.50 mm. | 39.00 mm. | 41.00 mm. | 2.33 | 35° |
| 94.50 mm. | 37.00 mm. | 40.00 mm. | 2.36 | 34° |
| 93.50 mm. | 36.50 mm. | 39.00 mm. | 2.39 | 34° (P)† |
| 92.50 mm. | 39.00 mm. | 40.50 mm. | 2.28 | 34° (P) |
| 91.00 mm. | 37.50 mm. | 39.50 mm. | 2.31 | 35° (H)† |
| 90.00 mm. | 35.00 mm. | 37.00 mm. | 2.43 | 37° |
| 88.00 mm. | 37.50 mm. | 39.00 mm. | 2.25 | 39° |
| 87.50 mm. | 35.00 mm. | 36.00 mm. | 2.43 | 38° (P) |
| 87.00 mm. | 36.00 mm. | 38.00 mm. | 2.28 | 36° (P) |

2. Great Island, N.E. Colony.

| Ht. | Diam. | Ap. ht. | Sp. ratio. | Sp. ang. |
|---|---|---|---|---|
| 100.00 mm. | 39.00 mm. | 42.00 mm. | 2.38 | 35° |
| 100.00 mm. | 39.00 mm. | 41.00 mm. | 2.44 | 36° |
| 99.00 mm. | 40.00 mm. | 42.50 mm. | 2.33 | 38° |
| 96.00 mm. | 38.00 mm. | 40.00 mm. | 2.40 | 35° |
| 95.00 mm. | 39.50 mm. | 39.50 mm. | 2.41 | 37° |
| 93.00 mm. | 39.00 mm. | 39.00 mm. | 2.38 | 36° |
| 92.00 mm. | 38.50 mm. | 40.00 mm. | 2.30 | 38° |
| 91.50 mm. | 38.00 mm. | 40.00 mm. | 2.28 | 36° |
| 91.00 mm. | 38.50 mm. | 39.00 mm. | 2.33 | 37° |
| 90.00 mm. | 37.50 mm. | 40.00 mm. | 2.25 | 40° |

* Iredale, 1944 (Aust. Zool. 10 (3), p. 309), quotes Mr. Roy Bell as recognising six different colonies of *bivaricosus*, separable in the field, and stating that the colonies apparently breed true.

3. North East Island.

| | | | | |
|---|---|---|---|---|
| 99.50 mm. | 43.00 mm. | 43.00 mm. | 2.31 | 40° |
| 97.00 mm. | 39.50 mm. | 41.00 mm. | 2.37 | 46° |
| 97.25 mm. | 41.00 mm. | 44.00 mm. | 2.21 | 44° |
| 97.00 mm. | 40.50 mm. | 42.00 mm. | 2.31 | 42° |
| 97.00 mm. | 38.50 mm. | 42.00 mm. | 2.31 | 42° |
| 96.00 mm. | 40.00 mm. | 42.00 mm. | 2.28 | 44° |
| 95.00 mm. | 40.00 mm. | 41.50 mm. | 2.28 | 42° |
| 93.00 mm. | 38.00 mm. | 41.00 mm. | 2.26 | 40° |
| 93.00 mm. | 37.00 mm. | 39.00 mm. | 2.38 | 40° |
| 91.50 mm. | 38.00 mm. | 41.50 mm. | 2.21 | 44° |

4. Great Island (N.W. landing slope).

| | | | | |
|---|---|---|---|---|
| 97.00 mm. | 36.00 mm. | 37.50 mm. | 2.58 | 33° |
| 92.50 mm. | 33.50 mm. | 37.00 mm. | 2.50 | 36° |
| 91.00 mm. | 36.50 mm. | 36.50 mm. | 2.49 | 38° |
| 91.00 mm. | 34.50 mm. | 36.00 mm. | 2.53 | 33° (H) |
| 90.50 mm. | 35.00 mm. | 35.00 mm. | 2.58 | 34° |
| 90.00 mm. | 34.00 mm. | 35.00 mm. | 2.57 | 36° |
| 89.50 mm. | 34.00 mm. | 34.00 mm. | 2.63 | 35° |
| 88.00 mm. | 33.00 mm. | 35.00 mm. | 2.51 | 33° |
| 87.50 mm. | 36.00 mm. | 36.00 mm. | 2.43 | 37° |
| 84.00 mm. | 33.50 mm. | 35.00 mm. | 2.40 | 38° |

5. Great Island (S.W. colony).

| | | | | |
|---|---|---|---|---|
| 113.50 mm. | 42.00 mm. | 44.00 mm. | 2.58 | 34° (H) |
| 112.50 mm. | 42.00 mm. | 44.00 mm. | 2.55 | 30° |
| 110.00 mm. | 40.00 mm. | 43.50 mm. | 2.53 | 30° |
| 109.00 mm. | 41.00 mm. | 43.00 mm. | 2.53 | 32° |
| 108.00 mm. | 40.00 mm. | 43.00 mm. | 2.51 | 31° |
| 108.00 mm. | 42.00 mm. | 46.00 mm. | 2.35 | 33° |
| 107.50 mm. | 39.50 mm. | 43.00 mm. | 2.50 | 31° |
| 106.50 mm. | 40.00 mm. | 46.00 mm. | 2.32 | 35° |
| 104.00 mm. | 40.00 mm. | 42.50 mm. | 2.44 | 35° |
| 104.00 mm. | 40.00 mm. | 43.00 mm. | 2.42 | 33° |

6. Great Island (Hapuku Point).

| | | | | |
|---|---|---|---|---|
| 102.00 mm. | 41.00 mm. | 41.00 mm. | 2.49 | 32° |
| 101.00 mm. | 34.00 mm. | 36.00 mm. | 2.81 | 26° |
| 100.00 mm. | 36.00 mm. | 41.00 mm. | 2.44 | 34° |
| 100.00 mm. | 38.00 mm. | 42.00 mm. | 2.38 | 37° |
| 98.00 mm. | 38.00 mm. | 41.00 mm. | 2.39 | 33° |
| 97.00 mm. | 38.00 mm. | 40.00 mm. | 2.42 | 33° |
| 97.00 mm. | 39.00 mm. | 42.00 mm. | 2.31 | 36° |
| 96.50 mm. | 35.50 mm. | 38.00 mm. | 2.54 | 30° |
| 93.50 mm. | 37.00 mm. | 41.00 mm. | 2.33 | 34° |
| 93.50 mm. | 35.00 mm. | 36.00 mm. | 2.59 | 31° |

† H = holotype, P = paratype.

## B.—Adult shells. Averages for each of six colonies.

| Colony. | Ht. | Diam. | Sp. ratio. | Sp. ang. |
|---|---|---|---|---|
| 1. | 91.65 mm. | 37.15 mm. | 2.33 | 36° |
| 2. | 94.75 mm. | 38.70 mm | 2.35 | 36.8° |
| 3. | 95.67 mm. | 39.55 mm. | 2.29 | 42.4° |
| 4. | 90.20 mm. | 34.60 mm | 2.52 | 35.3° |
| 5. | 108.40 mm. | 41.45 mm. | 2.47 | 32.4° |
| 6. | 97.85 mm. | 37.15 mm. | 2.47 | 32.6° |

### C.—The egg.

| Length. | Diameter. | Colony. |
|---|---|---|
| *17.50 mm. | 13.00 mm. | No. 1 |
| 17.70 mm. | 12.60 mm. | No. 2 |
| 16.70 mm. | 12.70 mm. | No. 2 |
| 17.00 mm. | 12.25 mm. | No. 3 |
| 16.80 mm. | 12.40 mm. | No. 3 |
| 16.00 mm. | 11.90 mm. | No. 3 |
| 15.75 mm. | 11.25 mm. | No. 3 |
| 15.70 mm. | 11.25 mm. | No. 3 |
| 15.50 mm. | 10.90 mm. | No. 3 |
| 15 00 mm. | 11.80 mm. | No. 3 |
| 15.00 mm. | 11.60 mm. | No. 3 |
| 14.50 mm. | 11.10 mm. | No. 3 |
| 12.70 mm. | 10 00 mm. | No. 3 |
| 15.395 mm. | 11.445 mm. | = Average for 10 examples No. 3 colony. |

* Suter, 1913 (Man. N.Z. Moll., p. 764), cited 18 mm as the length of this egg, which is in the Suter collection. Suter described the egg from old infertile examples as "calcareous, thin, white, finely granular, with a few larger granules irregularly interspersed." To this I now add that a fresh example laid by a captive specimen on 7/12/1945 had a thin, smooth, olive cuticle.

### D.—The embryonic shell.

| Height. | Diameter. | Colony. |
|---|---|---|
| 15.00 mm. | 12.00 mm. | No. 2 |
| 16.50 mm. | 11.00 mm. | No. 5 |
| 17.75 mm. | 12.25 mm. | No. 3 |
| 17.75 mm. | 13.00 mm. | No. 2 |

**Placostylus (Basileostylus) bollonsi bollonsi** Suter, 1908. Pl. 55, figs. 1-3.

1908—*Placostylus bollonsi* Suter Trans. N.Z. Inst. 40, p. 340, Pl. 25.

1913—*Placostylus bollonsi:* Suter Man. N.Z. Moll. p. 763, Pl. 30, figs. 11a, b (1915).

1935—*Placostylus bollonsi:* Powell Proc. Malac. Soc. 21 (4), p. 247.

1935—*Placostylus (Basileostylus) bollonsi:* Haas Zool. Anzeiger 15 (2), Br. 109, 7-8, p. 189.

1938—*Placostylus bollonsi:* Powell Rec. Auck. Inst. Mus. 2 (3) p. 150.

The typical species has a spire ratio of from 2.29 to 2.33; that is, the height of the shell is approximately two and one-third times the height of the aperture. The maximum dimensions recorded were 100.00 mm. in height by 39.00 mm. in diameter, and the minimum adult dimensions 87.00 mm. by 36.00 mm.

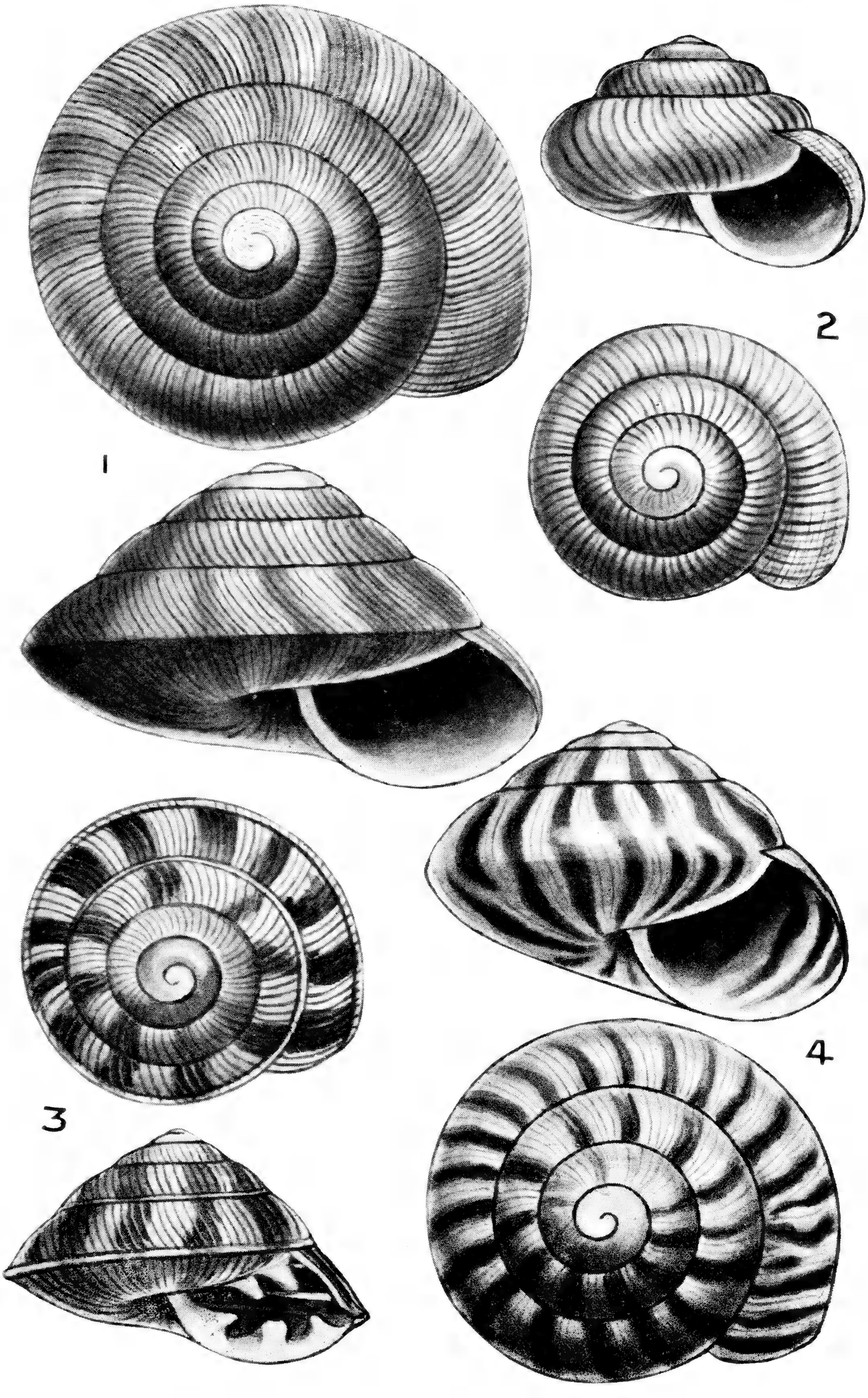



Fig. 1. *Laomarex sericea* n. sp., 2.00 mm. x 3.25 mm. North East Id. Holotype.

Fig. 2. *Paralaoma turbotti* n. sp., 1.00 mm. x 1.6 mm. Great Id. Holotype.

Fig. 3. *Laoma labyrinthica* n. sp., 1.5 mm. x 2.35 mm. Great Id. Holotype.

Fig. 4. *Phrixgnathus subariel* n. sp., 1.9 mm x 2.8 mm. North East Id. Holotype.

*Localities:* Great Island; No. 1 (type) colony on S.E. landing slope below the provision depot (now extinct). No. 2 colony at about 500ft. half a mile north-east from the provision depot (eleven snails counted). North East Island No. 3 colony (flourishing).

*Holotype:* In Suter Collection, N.Z. Geol. Survey, Wellington. 91.00 mm. × 37.50 mm.

**Placostylus (Basileostylus) bollonsi caperatus** n. subsp. Pl. 55, figs. 4, 5.

A smaller, narrower race with a taller spire than the typical species; spire ratio 2.40 to 2.58, height of shell approximately two and a-half times height of aperture. The maximum dimensions recorded were 97.00 mm. in height by 36.00 mm. in diameter, and the minimum adult dimensions 84.00 mm. by 33.50 mm.

Apparently the only available food for this colony is the leaves of the ngaio, *Myoporum lactum.* It is probable that lack of a normal diet of the leaves of *Corynocarpus, Melicope, Melicytus,* and probably *Meryta* (available under original conditions) has been one of the causes of the smaller adult size of this race.

*Locality:* Great Island; No. 4 colony, N.W. landing slope at about 500ft. in dense, stunted ngaio scrub (forty living snails counted).

*Holotype:* In Auckland Museum. 91.00 mm. × 34.50 mm.

**Placostylus (Basileostylus) bollonsi arbutus** n. subsp. Pl. 55, figs. 6, 7.

A large, narrow, tall-spired race with a spire ratio of 2.42 to 2.58, height of shell approximately two and a-half times height of aperture. The maximum dimensions recorded were 113.50 mm. in height by 44.00 mm. in diameter and the minimum adult dimensions 93.50 mm, by 35.00 mm.

A noticeable feature of this subspecies is the constantly narrower embryo, which is rendered more conspicuous by acceleration in the coiling of the subsequent whorls (see Table D for comparative dimensions of embryo from three localities).

*Localities:* Great Island; No. 5 colony on S.W. seaward slope just south of Crater Head at about 700ft. (twenty-five snails counted). No. 6 colony, several hundred yards east of Hapuku Point at about 600ft. (extinct).

*Holotype:* Auckland Museum, 113.50 mm. × 42.00 mm.

## ELASMATINIDAE

### Genus TORNATELLINOPS Pilsbry, 1915.

Type (o.d.): *Tornatellina novoseelandica* Pfeiffer, 1853.

**Tornatellinops novoseelandica (Pfeiffer, 1853).**

1913—*Tornatellina novoseelandica:* Suter Man. N.Z. Moll., p. 769.

1915—*Tornatellina (Tornatellinops) novoseelandica:* Pilsbry, Man. Conch. 23, p. 181.

*Type locality:* New Zealand.

*Locality:* North East Island, in leaf mould (G. A. Buddle, Jan., 1948).

This is the only Three Kings land mollusc so far found that is identical with a mainland species.

## APPENDIX.

Since the above was written a further landing was made on Great Island during Wednesday, 6th October, 1948, through the generosity of Mr. A. J. Black, of Dunedin, who transported a Museum party of four in his vessel, the m.v. "Alert." During four hours ashore I visited No. 4 and No. 5 *Placostylus* colonies and found marked regeneration of the surrounding vegetation. At the latter locality I gathered a bag of leaf mould which is now being sorted for small snails.

Already several new species have been located, but descriptions of these must be deferred for a later paper. The most striking addition is a further species of *Murdochia*, a relatively large trochiform snail, 6 mm. in diameter with two spiral series of hirsute processes.

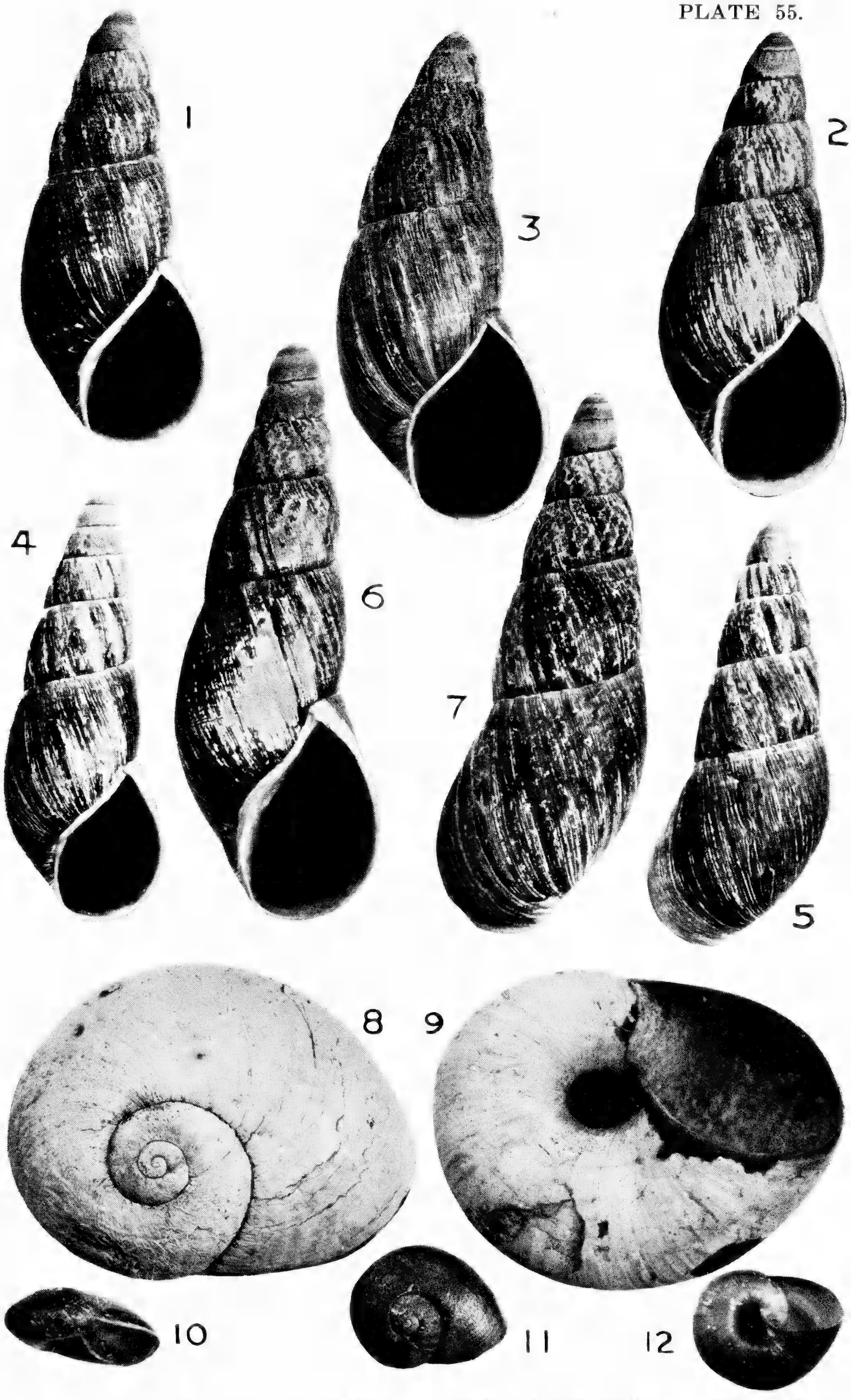



Fig. 1. *Placostylus (Basileostylus) bollonsi bollonsi* Suter, 1908. 91.00 mm. x 37.50 mm. Great Id. Holotype.

Fig. 2. *Placostylus (Basileostylus) bollonsi bollonsi*: Great Id., N.E. end, No. 2 colony.

Fig. 3. *Placostylus (Basileostylus) bollonsi bollonsi*: North East Id. No. 3 colony.

Figs. 4, 5. *Placostylus (Basileostylus) bollonsi coperatus* n. subsp. 91.00 mm. x 34.50 mm. Great Id., No. 4. colony. Holotype.

Figs. 6, 7. *Placostylus (Basileostylus) bollonsi arbutus* n. subsp. 113.50 mm. x 42.00 mm. Great Id., No. 5 colony. Holotype.

Figs. 8, 9. *Rhytida (Rhytidarex) buddlei* n. sp. 29.0 mm. x 64.0 mm. South West Island. Holotype.

Figs. 10-12. *Rhytida (Rhytidarex) johnsoni* n. sp., 11.5 mm. x 22.0 mm. Holotype (Fig. 11) and paratypes, North East Id.

# Collembola from the Three Kings Islands with a Description of Proisotomina, New Genus

By J. T. SALMON, D.Sc., F.R.E.S.,
Entomologist, Dominion Museum.

The species recorded in this paper were all obtained, using my portable extraction apparatus, from leaf-mould collected under large-leafed trees and ngaio trees on Great King Island of the Three Kings Group in May, 1946, by Mr. E. G. Turbott.

Six new species are described and new records, with brief descriptions, are given for three species previously unknown from the New Zealand region. Other known New Zealand species also recorded from the Three Kings Islands are:—

**Triacanthella rubra** Salmon.

**Podurrhippus armatus** (Nicolet).

**Brachystomella terrafolia** Salmon.

**Clavontella caerulumbrosa** Salmon.

**Mesaphorura minutissima** Salmon.

**Gnathalonche angularis** (Salmon).

**Megalothorax novae-zealandiae** Salmon.

## Genus **GNATHALONCHE** Börner, 1906.

With the addition of the following new species there now will be two species belonging to this genus known from New Zealand.

### **Gnathalonche sensilla** n. sp. Figs. 1-2.

*Colour:* White.

*Clothing:* Of moderately long, simple setae interspersed with equal length bristle-like setae which are very faintly serrated: on the dorsal surface are numerous short curved simple setae: the bristle-like setae are of almost equal width from base to tip, and some are arranged in rows, one transverse row of 4-5 bristles to each segment: sometimes the apex is slightly dilated.

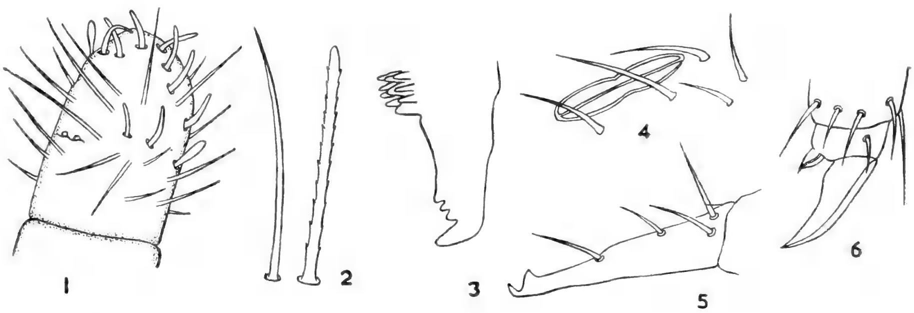
*Body:* Length, up to 1.1 mm. There is a boss to each side of the head, with an irregular boss-like mass between them, ocelli two to each side, unpigmented, one on the posterior lateral face of each side boss

and one on the head forward of the boss. Ants. III and IV fused. Ant. I of one antenna with a large sensory papilla, Ant. II of the other antenna with a similar sensory papilla. Ant. IV of both antennae with two similar large sub-apical sensory papillae, 8-9 apical and sub-apical long, bent, sense rods and numerous short and very long setae. The large sensory papillae of Ants. I, II, and IV are not always present and may denote a sexual character. About the centre of the fused segments III and IV are two small sensory papillae in a deep groove.

*Legs:* Claw granulate without any teeth, unguiculus absent.

*Type:* Microscope slide 4/1, Auckland Museum Collection.

*Co-type:* Slide 3/2190, Dominion Museum Collection.




Figs. 1-2. *Gnathalonche sensilla* n. sp. 1, Ant. IV, showing sense organs; 2, setae from body.

Figs. 3-6 *Folsomides neozealandia* n. sp. 3, apex of mandible; 4, postantennal organ; 5, mucro-dens; 6, foot.

## Genus FOLSOMIDES Stach, 1922.

The species described below is the first occurrence in New Zealand of this somewhat rare and interesting genus.

### Folsomides neozealandia n. sp. Figs. 3-6.

*Colour:* White, with two black ocellar spots.

*Clothing:* Of moderately long, simple setae.

*Body:* Length, up to 0.75 mm. Antennae three-quarters length of head, the four segments related as 6:8:10:15: Ant. IV without apical organ but with 7-8 long, curved sense rods among numerous curved setae of equal length; sense organ of Ant. III sub-apical and consisting of a pair of stout papillae arising from individual pockets. Postantennal organ long and narrow, six times as long as broad, double outlined with central longitudinal band and a constriction across the middle of the long axis; the whole organ may be a little less or a little longer than the width of Ant. I and is supplied with three guard setae. Segments of the body related as 7:6:5:5:5:7:4:3. Ocelli two to each side on black granular pigment spots, the anterior ocellus much larger than the posterior one. Rami of tenaculum each with three teeth. Mandible with large apical tooth and three smaller sub-apical teeth.

*Legs:* Claw without teeth but with a basal bulge on inner edge. Unguiculus present on hind feet but reduced, rudimentary, on fore and middle feet, a basal seta to each side of claw and a delicate non-clavate tenent hair, a little shorter than claw, to each foot.

*Furcula:* Mucrodens two-thirds length of manubrium; dens and mucro fused, bearing three ventral setae, the mucro with a sharp apical tooth and a longer sharp pre-apical tooth. Manubrium with four pairs of ventral setae and a lateral seta to each side.

*Type:* Microscope Slide 4/2, Auckland Museum Collection.

*Co-type:* Slide 3/2181, Dominion Museum Collection.

*Remarks:* This species is very closely allied to *F. exiguus* Folsom from Hawaii which it resembles in the structure of the feet and mucrodens; it differs quite distinctly, however, in the form of the postantennal organ and the apical dentition of the mandibles.

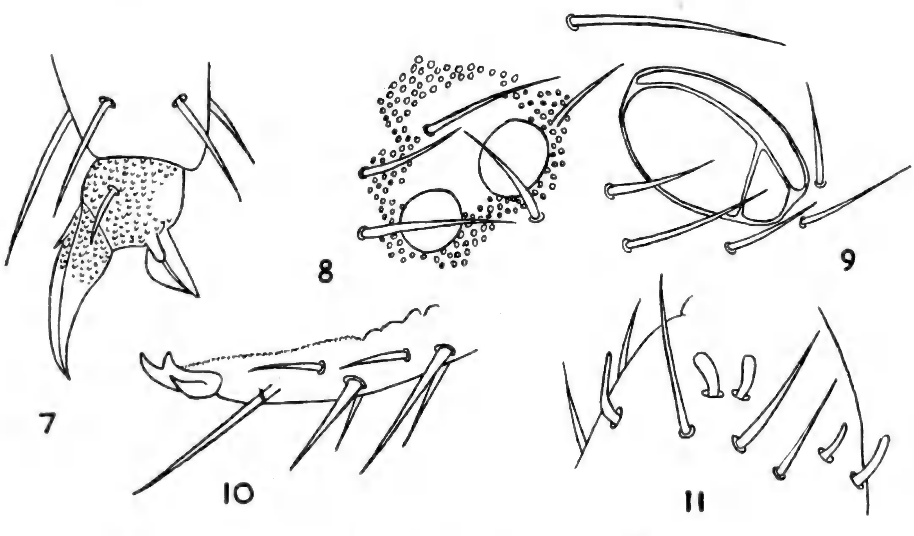
## Genus **SORENSIA** Salmon, 1948.

The occurrence of a species of this sub-antarctic genus on the Three Kings Islands is indeed interesting. *Sorensia* is described as a new genus in my recent paper on the Subantarctic Collembola, the type locality being Campbell Island. I have not yet located it on the mainland of New Zealand. With the inclusion of the Three Kings material the genus now contains three species.

**Sorensia anomala** n. sp. **Figs. 7-11.**

*Colour:* White, with black granular ocellar field.

*Clothing:* Short to moderate simple setae interspersed more particularly around posterior, with strongly serrated setae.




Figs. 7-11. *Sorensia anomala* n. sp. 7, foot; 8, ocelli; 9, postantennal organ; 10, mucro and apex of dens; 11, sense organs on Ant. III.

*Body:* Length, up to 1 mm. Antennae from one-third to a half as long again as head, the four segments related as 14:18:22:37. Ant. IV without apical sense organ but having many short, delicate setae interspersed with slender sense rods. Subapical sense organ of Ant. III consisting of a pair of stout straight sense rods, fully exposed, and, to one side, a slender rod somewhat removed, together with a fourth smaller rod close by between it and the pair, while somewhat removed on the other side is a single large curved sense rod. Ocellar pigment spot irregular with two ocellar spots and several guard setae. Postantennal organ elliptical, twice as long as wide, with central raised longitudinal brace and sometimes a side brace, the whole protected by four guard setae. Abd. III a little longer than IV. Rami of tenaculum each with four barbs; the corpus with two long, curved setae.

*Legs:* Claw granulate basally, without inner teeth but with a pair of very small outer teeth, one to each side, about one-third down. Unguiculus short, curved, with very broad inner and outer lamellae, of which the inner is curved, and with a prominent basal fingerlike process on inner surface. A fairly long basal seta to each side of claw. Sometimes on each hind foot a very slender usually faintly clavate tenent hair shorter than the claw.

*Furcula:* Reaching to posterior border of Abd. I. Dens two-and-a-quarter times as long as manubrium, annulated and corrugated along central section, the apical uncorrugated portion two to two-and-a-half times, the basal portion 12-14 times, length of mucro. Dens with several long simple apical setae; mucrodens joint indistinct; manubrium dorsally bearing numerous long spine-like setae; dens with 2-3 rows of short spine-like setae. Mucro with equal strong apical and sub-apical teeth and a large lateral basal tooth on inner edge.

*Type:* Microscope Slide 4/3, Auckland Museum Collection.

*Co-type:* Slide 3/2168, Dominion Museum Collection.

## Genus **FOLSOMINA** Denis, 1931.

### **Folsomina onychiurina** Denis, 1931. Figs. 12-13.

This is the first record in New Zealand of a genus and species which previously has been recorded only from Florida and Western Australia.

It is a small, white species of *Folsomina* facies up 0.7 mm. in length. Abd. IV-VI fused. Ocelli and postantennal organ absent. Antennae about half as long again as head. Ant. IV with two large sub-apical sensory papillae, close together, and four bent sense rods as well as a clothing of simple setae; Ant. III with two sub-apical short exposed sensory papillae each arising from its own pocket. Rami of tenaculum each with four teeth; corpus with two long, curved setae.

*Clothing:* Of simple setae longer posteriorly.

*Legs:* Claw without any teeth, unguiculus lanceolate, about one-third to a-half as long as claw. Tenent hairs absent. A long basal seta to each side of claw.

*Furcula:* Short. Dens two-and-a-half times longer than mucro, irregularly annulated and corrugated; mucro falciform.

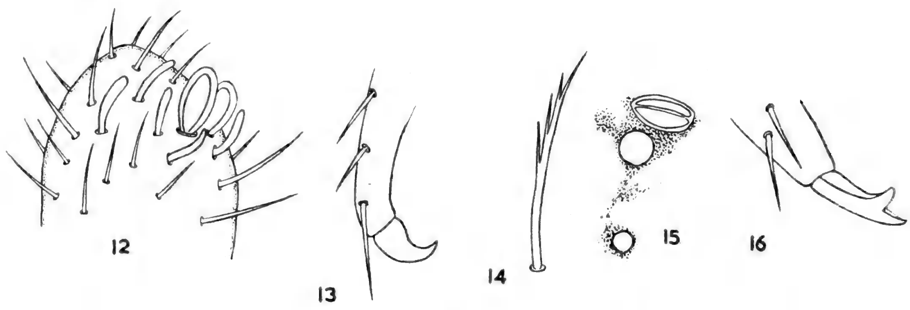
## Genus **ISOTOMINA** Börner, 1906.
## Genus **PROISOTOMINA** nov.

With the separation of *Isotomina* from *Proisotoma* on the fusion or not of Abds. V and VI, together with the separation of *Parisotoma* and *Isotomiella* from *Isotoma* by Bagnall on the basis of the number of ocelli, some difficulty occurs in correctly placing *Isotomina subalpina* Salm. and *Parisotoma linnaniemia* (Wom.), both of which have the ocelli reduced, and the fifth and sixth abdominal segments fused. I have decided, therefore, to erect a new genus *Proisotomina* for their reception and to redefine the genus *Isotomina* Borner as having *Abds. V and VI fused with eight ocelli to each side,* and the genus *Parisotoma* Bagnall as having *Abds. V and VI not fused with the ocelli reduced* to six or less on each side.

The genus *Proisotomina* nov. may then be defined thus:—

Abds. V and VI fused; ocelli six or less to each side; postantennal organ present. Ant. IV with apical sensory organ; Ant. III with sensory organ; clavate tenent hairs present or absent; furcula present but sometimes reaching only to Abd. II.

Genotype: *Proisotomina (Isotomina) subalpina* (Salmon, 1944).




Figs. 12-13. *Folsomina onychiurina Denis.* 12, apex of Ant. IV; 13, mucro and apex of dens.

Figs. 14-15. *Isotoma raffi* Womersley. 14, seta from posterior of body; 15, ocelli and postantennal organ.

Fig. 16. *Isotomina thermophila* Axelson. Mucro.

## Genus **ISOTOMINA** Börner, 1906.

One cosmopolitan species belonging to this genus occurs on the Three Kings Islands.

**Isotomina thermophila** Axelson. **Fig. 16.**

*Colour:* Light greyish blue, paler ventrally and on the appendages; ocellar fields darker blue.

*Clothing:* Of short, simple setae with a few longer ones posteriorly.

*Body:* Length, up to 0.8 mm. Antennae only slightly longer than head, the four segments related as 8:13:14:25. Ant. IV without apical sense organ but with numerous long, curved, tapering sense rods set amongst slender, straight setae. Sub-apical sense organ of Ant. III consisting of a pair of fully exposed straight or curved sense rods, each arising from its own pit. Ocelli eight to each side, sub-equal, with the anterior two, if any, the larger. Postantennal organ oval, twice as long as diameter of adjacent ocellus and two-and-a-half times as long as broad. Abd. IV a little longer than Abd. III. Rami of tenaculum each with four barbs.

*Legs:* Claw finely granulate, without any teeth or tenent hair, but with a long basal seta to each side. Unguiculus finely granulate about half as long as claw with outer edge straight and inner curved.

*Furcula:* Reaching to posterior border of Abd. II. Manubrium: dens: mucro as 20:23:5. Manubrium with a long, plain dorsal seta overhanging joint with dens and several ventral and lateral setae; dens with a few crude corrugations at middle, two rows of short dorsal setae, and 2-3 ventral setae. Mucro broad at base with small apical tooth and very large pre-apical tooth.

*Remarks:* This species is readily separated from the two species of *Isotomina* occurring on the mainland by the relatively short, fat mucro, which is unlike the usual tapering form of mucro found in this genus.

## Genus **ISOTOMA** Bourlet, 1839.

### **Isotoma raffi** Womersley, 1934. Figs. 14, 15.

Several specimens of this Australian species were amongst the Three Kings material and they constitute the first record of the species in New Zealand.

It is a greyish-white coloured insect with two small dark-pigmented ocellar patches on each side. Clothing of simple setae with longer, very strongly serrated setae posteriorly. Ocelli two to each side on separate pigment patches, the anterior ocellus much the larger; postantennal organ oval with longitudinal band or arch, twice as long as broad and two to three times longer than the anterior ocellus which it almost touches; rami of tenaculum each with four teeth.

*Legs:* Claw without teeth but with a long basal seta to each side; unguiculus about half as long as claw with broad inner and outer lamellae.

*Furcula:* Mucrodens about two-and-a-half times as long as manubrium, the mucro with equal apical and subapical teeth and a long lateral tooth in outer edge.

## Genus **PSEUDOSINELLA** Schaeffer, 1897.

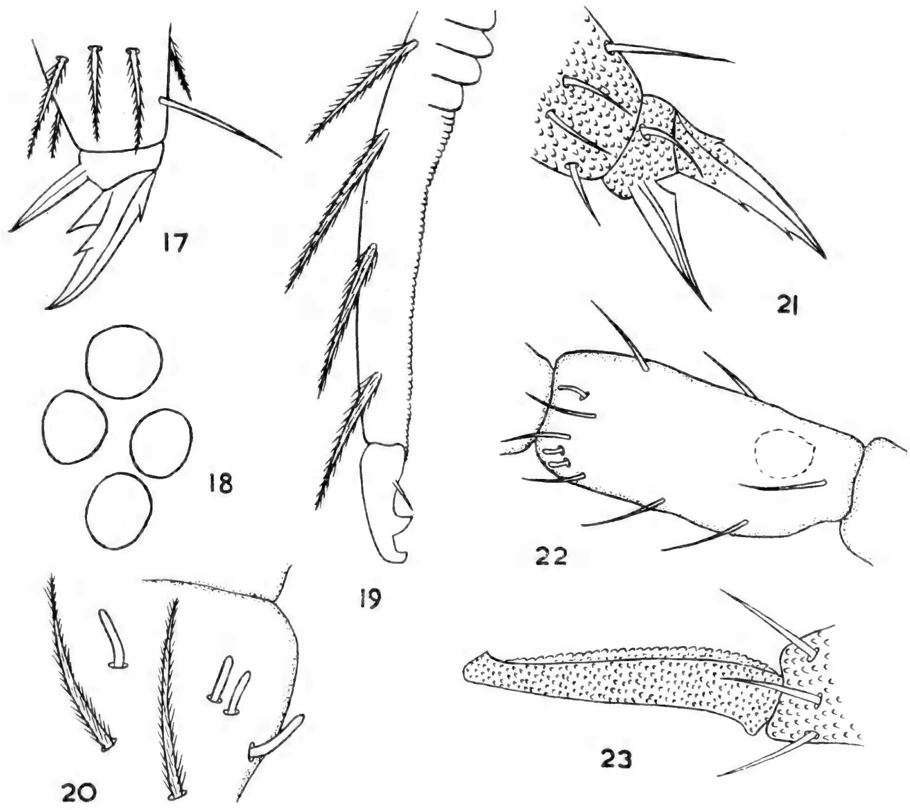
With the addition of a new species from the Three Kings there are now six species known in the New Zealand region.

### **Pseudosinella dispadentata** n. sp. Figs. 17-20.

*Colour:* White, the ocellar fields deep blue, Ant. IV with a bluish tinge.

*Clothing:* Of short ciliated setae and hyaline scales.

*Body:* Length, up to 0.8 mm. Antennae only a little longer than the head, the four segments related as 10:18:16:32. Ant. IV somewhat dilated, clothed with numerous short, curved ciliated setae interspersed with shorter straight tapering sense rods. Sub-apical sense organ of Ant. III consisting of a pair of short, straight, exposed sense rods close together and a longer bent sense rod somewhat removed to each side. Ocelli four to each side, subequal; bothriotrichia present on Abd. IV, which is about three times longer than Abd. III.




Figs. 17-20. *Pseudosinella dispadentata* n. sp. 17, foot; 18, ocelli; 19, mucro and apex of dens; 20, sense organ at apex of Ant. III.

Figs. 21-23. *Metakatianna nigraoculata* n. sp. 21, foot; 22, Ant. III, showing sense organs; 23, mucro and apex of dens.

*Legs:* Claw with a pair of large outer teeth one to each side, at about one-third down, and two large inner wing-like teeth, one at centre, the other just before centre. Unguiculus lanceolate and reaching to level of second inner tooth; a slender non-clavate tenent hair about half as long as claw to each foot.

*Furcula:* Manubrium and dens subequal, dens annulated and corrugated, the apical uncorrugated portion three times as long as mucro. Mucro elongate with two unequal teeth and basal spine, the apical tooth being small and slightly recurved, the subapical much longer.

*Type:* Microscope Slide 4/4, Auckland Museum Collection.

*Co-type:* Slide 3/2171, Dominion Museum Collection.

## Genus **METAKATIANNA** Denis, 1933.

In 1944 I described a species of *Metakatianna* from D'Urville Island. I can now add a further species from the Three Kings, making two species of the genus known from New Zealand, neither of which is found on the mainland.

**Metakatianna nigraoculata** n. sp. **Figs. 21-23.**

*Colour:* White, with deep-blue-black ocellar fields.

*Clothing:* Of normal simple setae, bothriotrichia of Abd. V extremely long, one to each side.

*Body:* Length, up to 0.3 mm. Antennae about half as long again as head, the four segments related as 6:10:12:30; Ant. IV faintly annulated, clothed with moderately long, simple curved setae and apically with 7-8 short, slightly bent sense rods; Ant. III with large sub-basal wart-like organ and apical sensory organ of two fully-exposed short straight sense rods arising close together, each from its own socket, and protected by two guard setae, and a third single similar sense rod, somewhat removed, with a single guard seta; ocelli eight to each side, the posterior and central ones very small, remainer large, equal; cuticle finely granulate.

*Legs:* Claw finely granulate basally with two small inner teeth, one near centre, the other at three-quarters down and two strong outer teeth, one to each side, at about one-third down. Unguiculus about half as long as claw with broad inner and outer lamellae, of which the inner has a strong angle near base; no tenent hairs, but a long, curved basal seta to each side of claw.

*Furcula:* Manubrium to dens to mucro as 8:20:8, dens with apical girdle of eight setae; mucro strongly granulate with slightly upturned apex, inner lamella very finely serrated; outer lamella plain.

*Type:* Microscope Slide 4/5, Auckland Museum Collection.

*Co-type:* Slide 3/2196, Dominion Museum Collection.

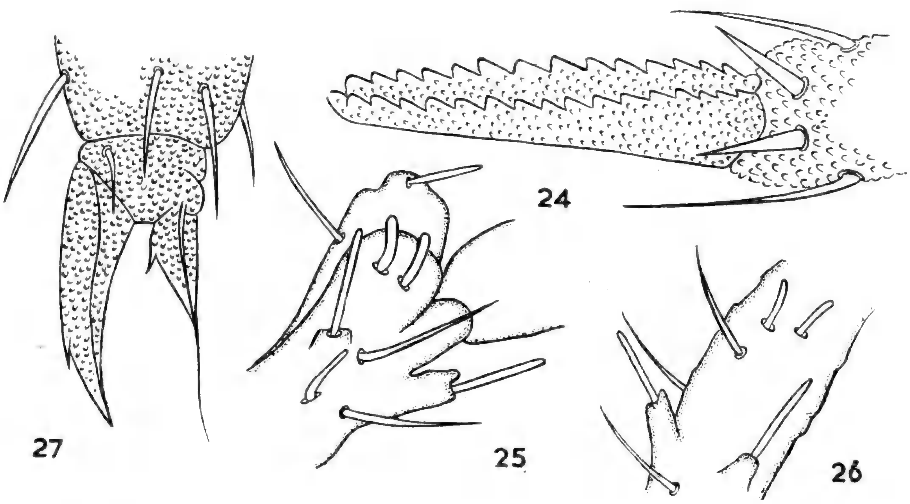
## Genus **DICYRTOMINA** Börner, 1906.

With the inclusion of the following new species four species and one sub-species belonging to this genus are now known from New Zealand.

### **Dicyrtomina turbotti** n. sp. Figs. 24-27.

*Colour:* Pale-yellow with purplish antennae, darkest towards tips; ocellar fields dark purple to black.

*Clothing:* Occasional simple setae with spines on top of head and around posterior of abdomen; dens with four pairs of ventral setae, numerous basal spine-like setae and an apical girdle of short, stout spines; legs sparsely clothed with short simple setae; four moderately long lasiotrichia to each side of abdomen, the upper bothriotrich on each side carries two lasiotrichia.




Figs. 24-27. *Dicyrtomina turbotti* n. sp. 24, mucro and apex of dens; 25, sense organs at apex Ant. III; 26, sense organs at centre Ant. III; 27, foot.

*Body:* Length, up to 0.8 mm. Antennae one-third as long again as head, the four segments related as 35:100:145:62; segments II and III (particularly the latter) with swellings and protuberances and sparsely clothed with stout simple setae; Ant. II with either a single or a pair of short exposed sense rods at one-third from base, a larger central sense rod with, usually, a pair of shorter ones and either a single or a pair of moderately long, straight, sub-apical sense rods; Ant. III sub-apically with a pair of long, curved, exposed sense rods and having each protuberance bearing a small sense rod; Ant. IV clothed with

numerous long curved setae and supplied with a small apical finger and 9-10 short straight sense rods. Ocelli eight to each side, the central one very small.

*Legs:* Claw finely granulate without tunica and without inner tooth but with a pair of strong outer teeth at four-fifths down; unguiculus two-thirds to three-quarters as long as claw, with narrow outer lamella and broad angular inner lamella bearing a prominent spine at angle, the apical bristle filamentous on fore and middle feet much over-reaching tip of claw, short and bristle-like on hind feet but still over-reaching claw tip; a short basal seta to each side of claw.

*Furcula:* Manubrium: dens: mucro as 20:45:13: Mucro broadly spathulate, distinctly granulate and coarsely serrated along both edges and round apex.

*Type:* Microscope Slide 4/6, Auckland Museum Collection.

*Co-type:* Slide 3/2161, Dominion Museum Collection.

# New Genera Species and Records of Orthoptera from the Three Kings Islands New Zealand

By J. T. SALMON, D.Sc., F.R.E.S., Entomologist,
Dominion Museum.

The material that forms the subject of this paper was collected by Mr. E. G. Turbott on Great Island, of the Three Kings Group, during May, 1946; and I am indebted to Dr. Gilbert Archey, Director of the Auckland Museum, for the opportunity to study the collection, which included Blattidae, Phasmidae, Tettigoniidae, and Stenopelmatidae.

## FAMILY BLATTIDAE.

Two species of cockroaches were included in the collection; the native *Platyzosteria undulivitta* Walker taken under stones, and the cosmopolitan *Supella supellectilium* Serville, which was beaten off kanuka, *Leptospermum ericoides*. This is the first published record of *S. supellectilium* occurring in New Zealand.

## FAMILY PHASMIDAE.

### TRIBE CLITUMNINI.

### Genus ACANTHOXYLA Uvarov, 1944.

One of the principal diagnostic characters of the Genus *Acanthoxyla* Uvarov is the presence of a well-developed spine on the base of the ovipositor, and, although this spine is only partly developed, possibly rudimentary, on the Three Kings specimens, their general characters indicate that they fall into this genus.

**Acanthoxyla senta** n. sp. Pl. 56, figs. 1-4; Pl. 57, figs. 1-3.

**Colour.**—Female: Both specimens are a rich chocolate-brown on the body and legs with the posterior intersegmental margins marked by orange-ochreous transverse bands; a black mid-dorsal spot on the posterior segmental margin of each segment; head and prothorax with faint whitish lines dorsally, and a narrow faint whitish or ochreous mid-dorsal longitudinal line extends from the head almost to the posterior border of the metathorax; antennae ochreous-brown with the segments tipped with black; eyes orange; bases of fore femora yellowish-ochreous. Legs banded on the femora and tibia with pale whitish or ochreous, irregular cloudy bands; claws and arolia brown.

Male: Both specimens are entirely a bright grass-green, with the posterior intersegmental margins marked by yellowish-ochreous transverse bands surmounted by a mid-dorsal black spot; faint yellowish lines dorsally on the head and prothorax; a narrow pale-ochreous to yellow

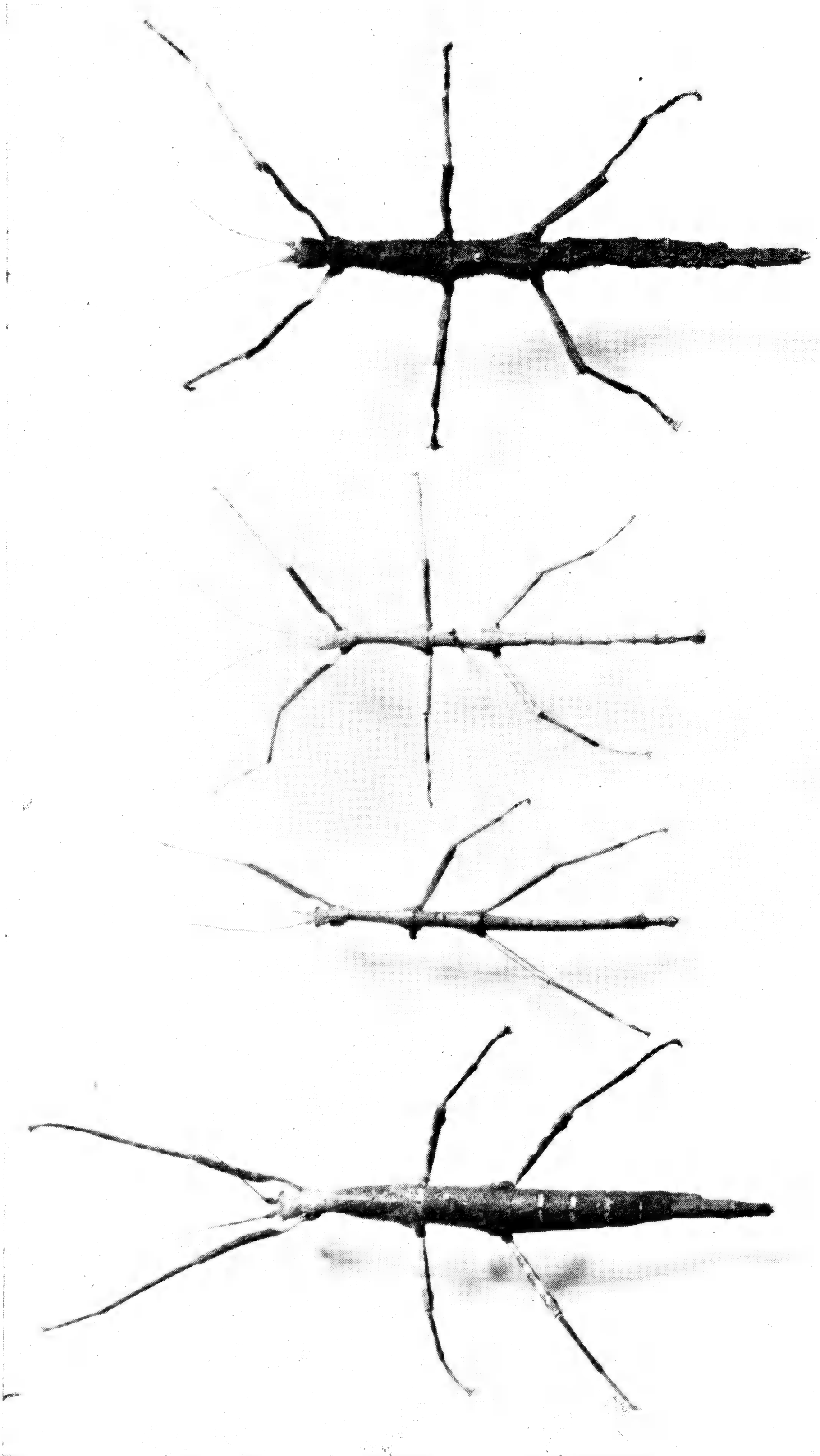
band extends down each side from the anterior border of the mesothorax to the posterior border of the metathorax; antennae ochreous-brown with the segments each black-tipped, eyes reddish, claws and arolia ochreous to orange.

**Body.**—Female: Length, up to 7.5 cms. Head broader than, and a little longer than, prothorax; mesothorax and metathorax subequal; Abd. I slightly shorter than Abd. II; Abds. IV, V, and VI distinctly longer than the rest; Abd. VI with a distinct lateral foliaceous lobe to each side posteriorly; Abd. VII constricted anteriorly but swelling posteriorly; Abd. IX approximately as wide as long; cuticle of the entire body bearing many minute dorsal and lateral tubercles which are larger on the head and prothorax; mesothorax, metathorax, Abds. I, II, and III all bearing, as well, both dorsally and laterally, very many small sharp spines; on the mesothorax and metathorax some of these form a lateral line down each side; some of the tubercles of the head may be extended as small spines and the spines of the first three abdominal segments may be reduced to tubercles; ventrally, the body with occasional tubercles on the thorax and anterior abdominal segments; median suture present, indicated by a dorsal inverted "V"-shaped translucent line of the cuticle at about two-thirds back on the metathorax. Occasional short bristles occur over the entire body.

Male: Length, up to 5.6 cms. Very much narrower and more parallel-sided than the female. The segmental proportions as in the female but with Abd. VII considerably widened posteriorly and very much shorter than Abd. VI; Abd. IX also considerably expanded posteriorly and carinate dorsally. Cuticle practically smooth except for some dorsal minute granulations on the mesothorax and a few tubercles on the head and prothorax; body smooth ventrally; a suggestion of a mid-dorsal carina on the thoracic segments; median suture present indicated by a dorsal recurved translucent line of the cuticle at about three-quarters back on the metathorax; cerci club-like, and clothed with short black bristles. Abd. IX bearing numerous short bristles. Occasional short bristles occur over the entire body.

**Antennae:** First segments, in both male and female, foliaceous, with stout central rib; second segments also foliaceous, but not so markedly so; less than half as long as the first segments and narrower; third segments narrower still but longer than the second; fourth much shorter than third; fifth to terminal elongate and more or less equal. Total number of segments in female, 23-24, in male 22-23. The antennae in both sexes clothed with many very minute hairs.

**Legs.:** Both male and female with the femora and tibiae of all three legs each bearing two carinae dorsally, and three ventrally, all of which are very finely serrated; the central one of the three ventral carinae, on the middle and hind femora, each with three small blunt teeth; the two outer ventral carinae, of the middle and hind legs, each with a very large, prominent, sharp, downwardly-directed tooth near the distal end; the fore femora unarmed; each leg segment, at its distal end, armed dorsally with a pair of small teeth, one to each side; first tarsal segment twice as long as second; the tibiae and tarsi clothed with minute hairs.



*Acanthoxyla senta* n. sp. 1, female, type; 2, male, type; 3, male, paratype; 4, female, paratype.

Photo, J. T. Salmon.

**Genitalia.**—Female: Ovipositor with the first or ventral valvulae completely enclosing the second and third valvulae, markedly carinate ventrally and angular basally, with a small blunt swelling on the carina at the basal angle; rounded posteriorly and extending to, or just beyond, the posterior border of Abd. IX. Cerci flattened, foliaceous, about two-thirds as long as Abd. IX and clothed with many short setae.

Male: Abd. IX, which is considerably expanded dorso-laterally, is also thickened along each latero-ventral edge and supplied along the thickening with a number of short stiff setae. The posterior border is lightly indented and runs inwards ventrally as two ridges, one to each side, each of which passes into a very stout inwardly-directed black spine. Harpagones moderately widely separated, curved, thickened, and club-like, and clothed with many short stiff setae. Thallobase large and tapering into a moderately long aedeagus which bears a number of slender setae around its apex. Accessory organs arising from Abd. VII.

**Types:** Male and female co-types in the Auckland Museum; male and female paratypes in the Dominion Museum, Wellington.

The co-types were mounted fresh by Mr. Turbott, and although they have lost some of their legs are really the better specimens as they show accurately the proportional lengths of the body segments. The paratypes were mounted after they had been preserved in alcohol and, although they are more complete as regards their appendages, shrinkage caused by the alcohol has masked the true proportional lengths of several of the segments.

The co-types were taken together on *Litsaea;* the paratypes were taken in copula on *Paratrophis.* The securing of these two male specimens is particularly interesting, as they represent the first male specimens of the genus *Acanthoxyla* to be captured. The mainland species of *Acanthoxyla* appear to reproduce pathogenetically and males, if produced at all, must be extremely rare.

## FAMILY TETTIGONIIDAE.

The only representative of this family in the collection was one specimen of *Xiphidium semivittatum* Walker, which was taken by beating *Leptospermum ericoides.*

## FAMILY STENOPELMATIDAE.
## SUB-FAMILY DOLICHOPODINAE.
## TRIBE CEUTHOPHILLINI.
### Genus **TURBOTTOPLECTRON** nov.

Type: *Turbottoplectron unicolor* n. sp.

Medium-sized stout insects with the head inclined underneath the body. Fore femora with one apical spine only on inner margin, middle femora with two apical spines, hind femora with one very small apical spine only on inner margin. Fore and middle tibia each with a pair of apical inferior spines and a pair of smaller lateral spines one to each side; hind tibia with two pairs of apical inferior spines of which the

upper pair is the longer, and two pairs of superior apical spines of which the lower pair is very much longer than any of the other apical spines. Fore and middle tibiae with occasional spines along both dorsal and ventral surfaces, hind tibiae smooth ventrally but with many short stout spines dorsally. First tarsal segment equal in length to the lengths of the remaining three combined. Subgenital plate of male broad basally, tapering abruptly to rounded apex, sparsely clothed with short hairs and grooved below.

This new genus is closest related to *Gymnoplectron* Hutton, from which it is really distinguished by having only one small apical spine on the hind femora.

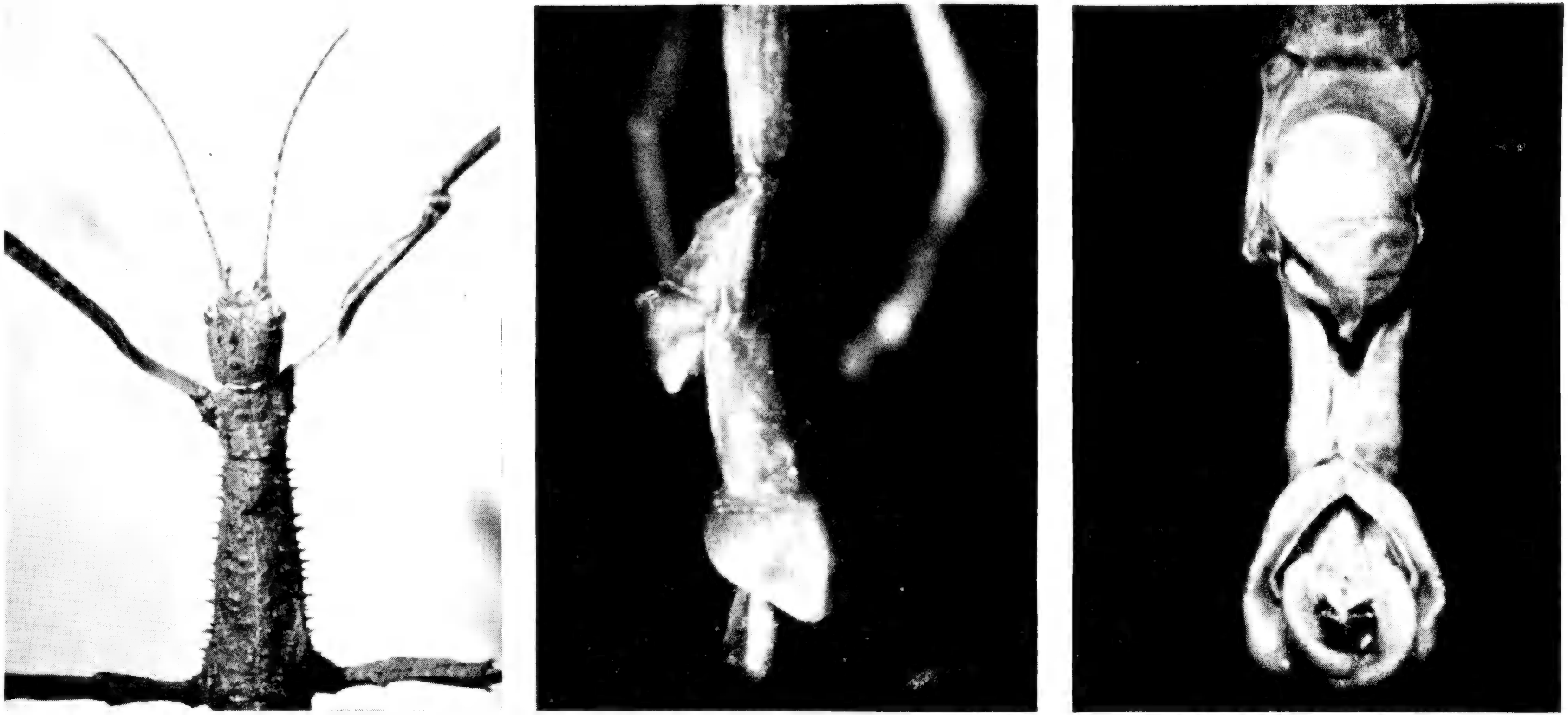
**Turbottoplectron unicolor** n. sp. Pl. 58, fig. 3; Pl. 59, fig. 1.

**Colour:** A uniform dark chestnut-brown on the body and appendages; base of hind femora with a number of transverse ocheous stripes.

**Body:** Length, up to 2.5 cms.; stoutest on mesothorax. Head smooth; vertex evenly rounded; fastigium rising abruptly, pyramidal and deeply sulcate; terminal segment of maxillary palpi distinctly longer than the sub-terminal. Eyes prominent. Thorax smooth, anterior border of pronotum extending slightly over occiput, its inferior margin horizontal, sharply curved anteriorly but more gently curved posteriorly; anterior margin of the pronotum and inferior margins of the pronotum and mesonotum markedly thickened, those of the metanotum not so; the inferior margins of the meso- and metanotum strongly and evenly curved and extending below that of the pronotum. Pronotum equal in length to the combined lengths of the mesonotum and metanotum. Sternum narrow. Abdomen smooth except for posterior margins of segments III to posterior, each of which is armed with a few fine hairs. Cerci long and tapering, clothed with many short bristles and numerous very long slender hairs.

**Antennae:** Very long, closely approximated at their bases but not touching; first segment large and stout but longer than broad, second segment much narrower and about one-quarter length of first; third segment tapering, about two and a-half times length of second; fourth segment about equal to second in length; remaining segments much shorter, subequal; the first and second segments thickly clothed with short, stiff setae, only sparsely clothed along the central portion; towards apex antennae have become heavily clothed with fine hairs which are approximately as long as the diameter of the segments; total number of segments variable from 186-200; occasional segments towards apex appear to be fused and segments in distal portion are difficult to make out.

**Legs:** Fore coxae only, each with a large sharp spine on the forward edge. All the femora deeply grooved below, and spined, rounded above and evenly clothed with short adpressed setae; fore femora with five spines on inner ventral keel, the proximal spine very small, distal one largest; middle femora with four spines on anterior ventral keel and



*Acanthoxyla senta* n. sp. 1, Head and anterior portion of thorax, showing spines and tubercles. 2, Terminal abdominal segments of male from side. 3, Terminal abdominal segments of male from below.

Photo, J. T. Salmon.

three spines on posterior ventral keel, proximal ones small, distal ones largest; hind femora with ten spines on inner ventral keel and thirteen spines on outer ventral keel, of which the proximal three are very small. Fore tibiae rounded above and below and armed with three pairs of moderately long ventral spines in addition to the apical ones, thickly clothed with fine hairs; middle tibia also rounded above and below clothed with fine hairs, armed ventrally with three pairs of moderately long spines in addition to the apical ones, and along both the inner and outer lateral margins a proximal and a distal spine; hind tibiae carinate dorso-laterally, with a shallow dorsal groove between the carinae rounded ventrally, clothed with fine hairs; except for the apical spines there are no ventral spines, but dorsally in addition to the two apical pairs of spines the inner carina bears 32-33 spines, the outer carina 34 spines; in both cases the proximal spines are extremely small, but the spines increase in size towards the distal extremity of the tibia. Tarsi all strongly carinate below and clothed with fine hairs which are longer than those on the other leg segments; the large apical spines of the hind tibiae also are clothed with fine hairs.

*Locality:* Great Island, Three Kings Group, on kanuka.

*Type:* Male, in Auckland Museum, paratype male in Dominion Museum. Female unknown.

## TRIBE RHAPHIDOPHORINI.

### Genus **PARANEONETUS** nov.

Type: *Paraneonetus multispinus* n. sp.

Small, stout insects with the head held almost vertical. Fore and middle femora both with a pair of long apical spines, hind femora with only one very small apical spine on inner margin. Fore and middle tibiae both with a pair of apical ventral spines and a pair of shorter lateral apical spines, one to each side; hind tibiae with two pairs of apical ventral spines of which the upper are the longer, and two pairs of apical dorsal spines of which the upper are the shorter, the other pair being very long, over half the length of the first tarsal segment; all tibiae with numerous spines additional to the apical spines. First tarsal segment of fore tarsus much longer than the remaining segments combined; first tarsal segment of middle and hind tarsi twice the length of the second segment and approximately equal in length to the remainder of the tarsus in each case; first and second segments of the hind tarsi only, each with a pair of strong apical dorsal spines. Subgenital plate of male rugose, broad, apically truncate, with conspicuous elevated, transverse, curved, sub-apical, ventral ridge and thickened lateral margins towards apex; subgenital plate of female short, triangular, deeply notched at apex so as to form two lobes, each of which is heavily clothed with short hairs. This genus probably is nearest related to *Neonetus* Brunner, coming between it and *Weta* Chopard but differing from both in the apical spination of the tibiae and the form of the subgenital plate in both the male and the female.

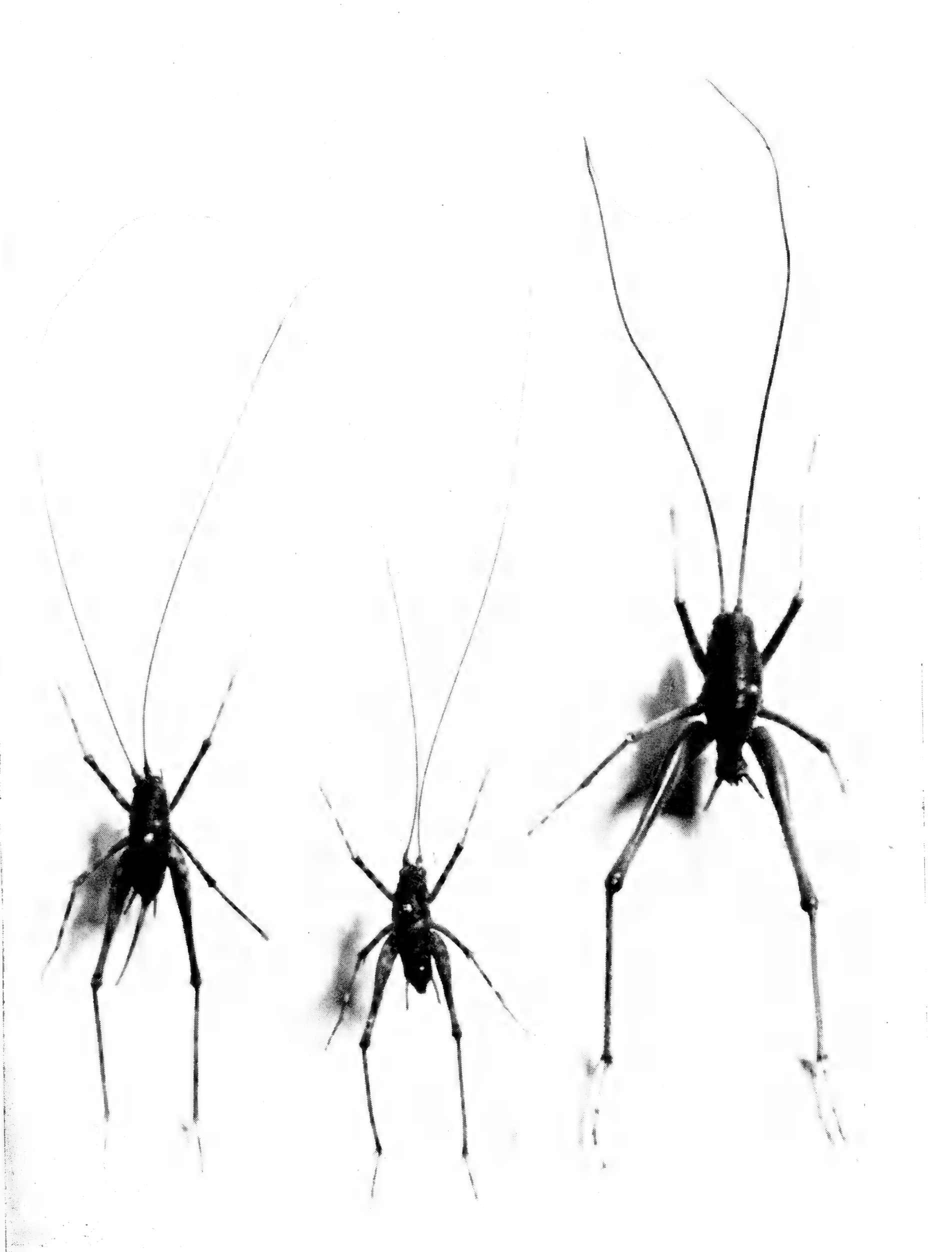
**Paraneonetus multispinus** n. sp. Pl. 58, figs. 1, 2; Pl. 59, fig. 2.

**Colour:** Chestnut-brown overlaid by patches of dark-brown or black on the sides of the thorax and Abd. I, patches on other abdominal segments form two dorsal and two dorso-lateral longitudinal stripes; head ochreous brown with two dorsal longitudinal black stripes leading to fastigium and two similar stripes leading to eyes; maxillary palpi light ochreous, darkening basally; antennae dark-brown with 9-11 light ochreous bands spaced at intervals along the entire length; fore and middle femora and tibiae and hind tibiae ochreous with broad bands of dark-brown; hind femora darker ochreous brown irregularly marked dorsally and laterally with dark-brown; tarsi ochreous, first segment of the hind tarsus with a broad apical band of dark-brown.

**Body:** Length, up to 1.75 cms.; stoutest on mesothorax; cuticle with a delicate velvety texture and clothed evenly but rather sparsely with very short, fine, adpressed hairs. Head mostly naked except towards fastigium, where it is relatively heavily clothed with longer fine hairs, fastigium rising very abruptly, pyramidal, very deeply grooved and clothed with fine hairs; eyes very prominent; terminal segment of maxillary palpi much longer than sub-terminal and considerably swollen apically. Anterior border of pronotum extending forward over occiput, its inferior margin horizontal and gently curving both anteriorly and posteriorly; anterior margin of pronotum and inferior margins of pronotum and mesonotum distinctly thickened, the posterior portion of that of the mesonotum very markedly so; the inferior margins of the mesonotum and metanótum extending down only slightly further than that of pronotum. Length of pronotum almost equal to combined lengths of mesonotum and metanotum; sternum narrow; cerci long and tapering, clothed with both short fine and very much longer fine hairs; ovipositor longer than body.

**Antennae:** Approximating at their bases but not touching, the first segment dilated and about four times longer than second; second much narrower than first; third narrower still and one and a-half times longer than second on dorsal aspect, but equal on ventral aspect; fourth onwards sub-equal; basal segments sparsely clothed with short fine hairs, the first segment dorsally with many longer dark-brown setae; the density of the clothing increases towards the apex of the antennae but the hairs remain short interspersed occasionally with rather longer isolated ones. Segmentation becomes obscure towards apex but each antennae has approximately 540 segments.

**Legs:** Fore coxae only, each armed with a long sharp spine on forward edge. Fore and middle femora grooved below, the edges of the grooves rounded, hind femora deeply grooved with the edges strongly carinate; all femora rounded above and heavily clothed with short dark-brown adpressed setae; fore femora bearing eight small spines on the inner ventral edge, the proximal two extremely small, and two spines on the outer ventral edge; middle femora similarly with eight small spines on the anterior ventral edge, none on the posterior edge; hind femora with 23-29 spines on the inner carina, the proximal 2-4 very



*Paraneonetus multispinus* n. sp. 1, female type. 2, male type.

*Turbottoplectron unicolor* n. sp. 3, type.

Photo, J. T. Salmon.

small, and 33-34 spines on the outer carina, the proximal four being extremely small; inner edge of each hind femoral carina with a single row of fine, moderately long stiff hairs. Fore and middle tibiae rounded above and below, hind tibia rounded below but broadly grooved and lightly carinate on the edges dorsally; fore tibia with two dorsal rows each of 9-10 small spines situated inside the proximal half, a pair of long ventral spines near the centre and a further smaller pair near the apex in addition to the apical spines; middle tibia similarly bearing two dorsal rows of small spines of which the anterior row contains 4-6 spines and the posterior 9-10 spines and two pairs of ventral spines as in the fore tibia; hind tibia with 38-44 spines on inner dorsal carina and 43-46 on outer carina; no additional ventral spines; tibiae heavily clothed with fine short setae. All tarsi grooved and carinate ventrally, rounded dorsally and clothed with moderately long fine setae; the large apical spines of the hind tibiae also clothed with fine setae.

*Locality:* Great Island, Three Kings Group, in caves and on kanuka, *Leptospermum ericoides.*

*Types:* Male and female co-types and paratypes in Auckland Museum. Male and female paratypes in Dominion Museum, Wellington.

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# New Species and Records of Lepidoptera from the Three Kings Islands, New Zealand.

By J. T. SALMON, D.Sc., F.R.E.S., Entomologist,
Dominion Museum.

A small collection of Lepidoptera made on the Three Kings Islands by Mr. E. G. Turbott, of the Auckland Museum, during April and May of 1946, was kindly passed over to me for study. It contained three new species and one new sub-species, each of which, with two exceptions, are represented by the type specimen only; but as they are from a locality that is so seldom visited, I have decided to describe and figure them in order that future visitors who land on these islands may look out for additional specimens of these unique moths. A more concentrated attempt to collect Lepidoptera on the Three Kings may quite possibly yield further unusual species.

**Porina unimaculata** n. sp. Pl. 60, fig. 1.

The expansion of the wings is 60 mm. The general colour of the wings and body is a medium tone of brown; the hind wings slightly lighter in tone than the forewings, more of a greyish-brown, tinged, when fresh, with reddish-orange towards base and along the costa. Forewings with the costa almost straight, *a conspicuous white diamond-shaped discal spot*, a very small sub-costal white spot outlined in dark-brown about one-quarter from base, a second similar spot below this, a little more than the distance the sub-costal spot is from the costa, but a little nearer the base, and a pair of similar spots slightly basal to the centre of the dorsum; the *lower spot of this pair is on one end of a black crescent-shaped mark* which curves in towards the dorsum; there is an irregular and indistinct broad, dark-brown median band and a further similar distal band containing some irregular minute white dots; this band follows the curve of the tornus and dorsum and may meet the black, crescent-shaped mark; the sub-terminal line is faint, consisting of a series of narrow dark-brown patches. The veins on the hind wings are picked out with ochreous, and the cilia of both fore and hind wings are brown.

The antennae have the distal margin of each segment expanded into a distinct collar which bears a circlet of short stiff hairs. This distinct species is described from a unique specimen captured by Mr. Turbott at light on Great Island, Three Kings.

*Type:* In the Auckland Museum collection.

**Heliostibes bilineata** n. sp. Pl. 60, fig. 3.

The expansion of the wings is 15 mm. The forewings are somewhat rectangular in shape, on the distal half, with the costa strongly arched to the base; dark-brown in colour with a cloudy blackish spot at centre and another at two-thirds; *between these two spots from the costa almost to the dorsum runs a broad band of whitish scales superimposed upon the ground of dark-brown; beyond the distal blackish spot is a second similar whitish line;* these two lines are inclined towards one another and may be joined by a thin line above the dorsum giving the appearance of a broad "U"-shaped band. There is a small tuft of whitish scales basally on the costa and another on the dorsum. Bright-orange scales are sparsely scattered over the entire forewings and impart a pleasing bronzy reflection to them. Hind wings dark-brown with the costa broadly white basally, narrowing towards apex, and *shaded with bright orange-yellow from the base almost to the centre.*

Cilia of the forewings dark-brown, of the hind wings ochreous-brown shaded with dark-brown at the base. Head and thorax heavily scaled; patagia small, dark-brown. Body entirely dark-brown above with transverse intersegmental bands of bright-orange across the abdomen; below it is profusely shaded with whitish scales. Legs, antennae, and palpi dark-brown similarly shaded with whitish scales.

*Locality:* Great Island, Three Kings Group, from flowering kanuka trees.

Type and paratypes in Auckland Museum Collection; paratypes in Dominion Museum Collection.

**Lysiphragma argentaria** n. sp. Pl. 60, fig. 2.

One perfect specimen of this species was captured on Great Island at light by Mr. Turbott. It is a very small moth rather unlike any of the three known species of *Lysiphragma;* but by the nature of the palps and wing venation it falls into this genus.

The expansion of the wings is 12 mm. The general colour is silvery white on the forewings and head; pale-grey on the thorax, with patagia whitish; pale-ochreous white on the abdomen and silvery-grey on the hind wings, with strong metallic reflections. The forewings are clouded with scattered grey scales along the costa from the base to about three-quarters; there is an apical cloudy-grey patch and a similar sub-apical patch on the tornus; basal streak marked by a line of yellowish-orange scales terminated by two or three very dark-brown scales. Cilia of the forewings pale-brown, of the hind wings silvery-grey. The costa of the forewings is gently arched, the dorsum almost straight, the apex rounded and acute. Antennae dark-brown banded with white; palpi brown shaded with white. Head and thorax heavily scaled. Legs greyish-white.

*Type:* In the Auckland Museum Collection.

**Ctenopseutis obliquana** Walker subsp. **distincta** nov. Pl. 60, fig. 4.

This outstanding and unusual form of this well-known species is sufficiently unique in appearance combined with its geographical isolation on the Three Kings Islands to warrant the erection of a sub-species.

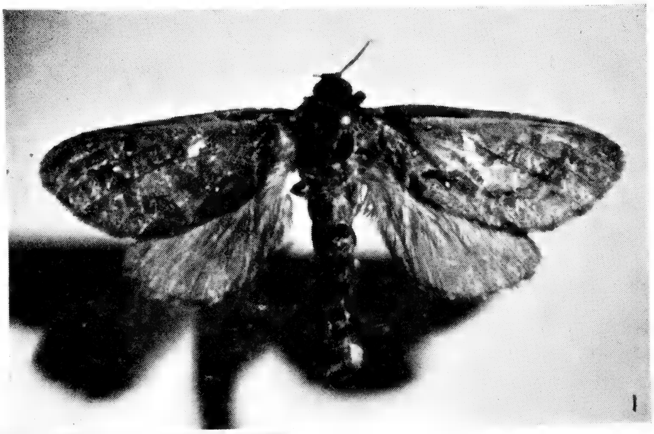
The expansion of the wings is 21 mm. The forewings' general ground colour is a medium reddish-brown with the veins faintly clouded with ochreous-brown and dotted irregularly by small clumps of very dark reddish-brown scales; the costa, especially towards the base, barred with dark reddish-brown; a broad longitudinal ochreous band extends from the base to the apex; it is broadest near the centre, then sharply constricted on lower margin; at about two-thirds it is distinctly broken and continues upward to apex gradually narrowing; a similar short narrow line extends from base to about one-third along costa, and a faint cloudy-ochreous shading extends across the break in the longitudinal line between it and the costa. The breadth of the ochreous line varies towards the apex and in one specimen almost disappears. Hind wings paler reddish-brown. Cilia of the forewings medium ochreous-brown, of the hind wings light ochreous. Antennae reddish-brown, hairy; head and palps strongly scaled with reddish-brown scales; thorax darker brown suffused with reddish-brown and ochreous scales; patagia dark-brown suffused with ochreous and distinctly reddish basally; abdomen ochreous sparsely suffused with dark-brown scales; front and middle legs dark-brown suffused with ochreous, hind legs ochreous suffused with brown.

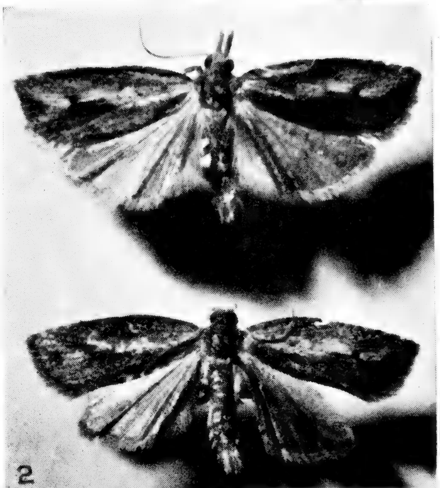
*Locality:* Great Island, Three Kings; Tasman Valley on tea-tree.

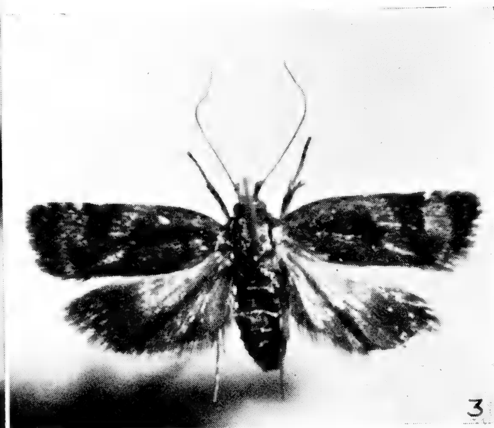
*Type:* In Auckland Museum Collection; paratype in Dominion Museum Collection.

Another somewhat unusual form of this moth also was included in the collection, in which the forewings are pale-reddish-ochreous irregularly speckled with small black spots. However, this form is known also from the mainland.

The other species recorded in the collection (taken at light) were: *Diptychophora selenaea, Selidosema suavis, Melanchra lignana.*







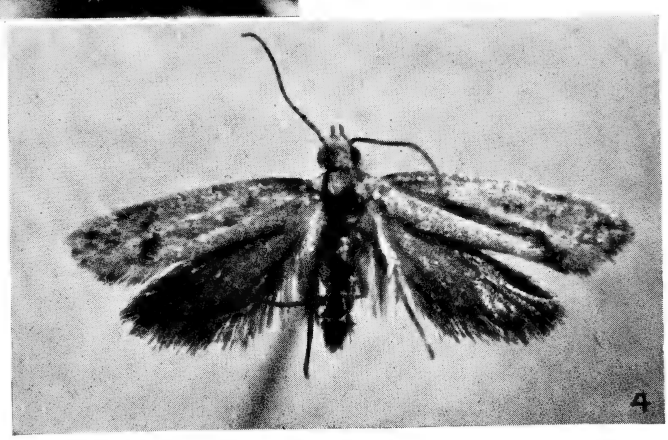


Fig. 1. *Porina unimaculata* n. sp. type.

Fig. 2. *Ctenopsutis obliquana distincta* n. subsp. Type above, paratype below..

Fig. 3. *Heliostibes bilineata* n. sp. type.

Fig. 4. *Lysiphragma argentaria* n. sp.

Photo, J. T. Salmon.

# A New Sub-Family and Species of New Zealand Opiliones

By R. R. FORSTER, Canterbury Museum, Christchurch.

In the following paper are described two new genera and species of harvestmen collected by Mr. E. G. Turbott on the Three Kings Islands. I wish to thank Dr. G. Archey (Director, Auckland Museum), for the opportunity of examining and describing this material.

As one of the species of new genera found in this material belongs to a new sub-family, of the family *Phalangiidae*, which had been established in manuscript for a species collected by the author at Titirangi, Auckland, this species also has been included in the present paper.

The *Phalangiidae* was previously divided into seven sub-families, of which one, the *Phalangiinae*, was recorded from N.Z. The sub-family *Monoscutinae* n. sub-fam. would appear to be most closely related to *Oligolophinae*, which is widely distributed in the northern regions of the world. However, the N.Z. sub-family is clearly distinguished from the *Oligolophinae* by the relative shortness of the legs, the general lack of dorsal abdominal segmentation, and the uniform denticulation of the cutting edges of the cheliceral fingers.

The sub-family is limited to the northern portions of the North Island of New Zealand.

## ORDER OPILIONES.

## SUB-ORDER PALPATORES.

## FAMILY PHALANGIIDAE.

## SUB-FAMILY MONOSCUTINAE n. sub-fam.

Body flattened, thickly chitinised. Cephalothorax and all tergites fused, not divided by transverse grooves. Abdominal sternites fused, but sometimes faintly separable by transverse grooves. Corona analis absent. Openings of odoriferous glands clearly visible from above. Coxae I and IV without anterior or posterior rows of granules. Maxillary lobes of coxae II slender, directed anteriorly towards the anterior margin of the genital operculum, forming with each other an obtuse angle. Basal segment of mandibles with single ventral forwardly directed spine. Cutting edge of fingers armed with small, uniform-sized teeth. Pedipalp tarsus much longer than tibia, terminated by distinct, simple, smooth claw. Legs relatively short. Secondary sexual characters slight or absent. Two genera in N.Z.

## Genus MONOSCUTUM n. gen.

Eye mound spherical, clearly removed from the anterior margin of the carapace; with single median tubercle rising anterior to the eyes. Cephalothorax and all tergites fused, transverse grooves absent; but divided behind eye mound into areas by transverse lines of small pustular papillae. Third such area with median pair of spines. Rest of body without spines. Sternites fused, hard, divided by faint transverse grooves which do not reach the sides.

Spiracles hidden.

Mandibles short, basal segment armed below with single forwardly directed spine. Pedipalp longer than body. Patella with well-developed inner distal apophysis. Tarsus nearly twice as long as tibia and terminated by simple smooth claw.

Legs short, 2, 4, 3, 1.

Tarsal segments, more than 20.

Genotype *M. titirangiensis* n. sp.

**Monoscutum titirangiensis** n. sp. Pl. 60, figs. 1-4.

**Body:** Eye mound spherical, placed one half its diameter from the anterior margin of cephalothorax; armed with single median blunt tubercle, rising from between and slightly in front of the eyes, and directed forward. Anterior margin of cephalothorax with one median indentation, enclosing the chelicerae, and two lateral indentations on each side enclosing coxae I and II respectively. Cephalothorax and sternites as in generic description, with eight transverse rows of papillae behind eye mound. Sternites as in generic description, smooth, with papillae or spines. Genital operculum large, widening distally, sparsely covered with small black setae.

**Chelicerae:** Basal segment armed below with single, small, forwardly directed spine, apart from which the chelicerae are smooth. Fingers crossed when closed; cutting edges with numerous small uniform-size teeth.

**Pedipalp:** All segments covered with numerous small black setae. Patella with prominent inner distal apophysis (Fig. 3). Tarsus slender, nearly twice as long as tibia. Claw, distinct, smooth.

**Legs:** 2, 4, 3, 1. Coxae smooth. Trochanter I-III with one antero-lateral and one postero-lateral spine. Trochanter IV with only one antero-lateral spine. Remaining segments smooth. All segments clothed with small black setae. Tarsal segments 21, 60, 20, 22.

**Colour:** Body light-brown except for a median black area surrounding the two spines on the tergum, behind which extends a lighter area. All legs and appendages uniform light-brown. Eye mound grey, eyes black.

**Measurements:**

| | Body | .. | .. | Length 2.5 | | Width 1.8 | | |
|---|---|---|---|---|---|---|---|---|
| | Cox. | Troch. | Fem. | Pat. | Tib. | Met. | Tars. | Total. |
| Leg I | .5 | .3 | 1.0 | .45 | 1.05 | 1.25 | 2.25 | 6.8 |
| Leg II | .7 | .3 | 2.55 | .75 | 3.35 | 1.35 | 7.0 | 16.0 |
| Leg III | .9 | .25 | 1.05 | .4 | 1.0 | 2.0 | 1.5 | 7.1 |
| Leg IV | .95 | .4 | 1.6 | .5 | 1.5 | 3.25 | 1.6 | 9.8 |
| Pedipalp | .25 | .4 | .7 | .4 | .5 | | .9 | 3.15 |

Chelicera .. Basal .7 Second .8 Total 1.5

*Type:* Dominion Museum Collection, Tube 2/60.

*Locality:* Titirangi (Type Loc.) Coll. R.R.F.

## ACIHASTA n. gen.

Eye mound spherical, less than half its diameter from anterior margin of cephalothorax, armed with single large upwardly-directed spine, rising from between eyes. Cephalothorax and tergites fused, without transverse grooves, but divided behind eye mound by transverse granular ridges. Posterior margin of body fringed with strong spines. Sternites fused, no transverse grooves visible. Spiracles hidden. Pedipalp longer than body; patella with prominent inner distal apophysis. Tarsus nearly twice as long as tibia. Claw, distinct, smooth. Legs short. Tarsal segments more than 13.

Genotype *Acihasta salebrosa* n. sp.

### Acihasta salebrosa n. sp. Pl. 60, figs. 5, 6.

**Body:** Eye mound spherical, rising from immediately behind anterior margin of cephalothorax, armed with strong median upwardly directed spine between eyes. Both eye mound and spine coarsely granulated. Deep median indentation of cephalothorax encloses basal portions of chelicerae and pedipalp. No lateral indentations present. Entire dorsal body area, including spines, coarsely granulated. Cephalothorax with three spines on each side; a small one immediately below each of the lateral limits of the median indentation, a further small one on each lateral margin in line with the middle of the eye-mound and a third large spine on each side a quarter way down the body. Body area behind the large spines divided by nine transverse granular ridges into nine areas. Fifth to ninth such areas with a strong laterally-directed spinous outgrowth on each lateral margin, forming a postero-lateral fringe to the body. (Fig. 5.)

Abdominal region anteriorly wider than cephalothoracic region. Sternites fused, smooth, segmentation not visible.

**Chelicera:** Basal segment ventrally with forwardly-directed proximal spine. Otherwise smooth. Fingers crossed when closed, cutting edges with numerous regular teeth.

**Pedipalp:** Finely granulated, covered with numerous fine whitish setae. Patella with strong inner distal apophysis. Tarsus nearly twice length of tibia. Claw distinct, smooth.

**Legs:** Short. 2, 4, 3, 1.

All segments except tarsi finely granulated. No setae present. Trochanter I to III with one antero-lateral and one postero-lateral blunt tubercle. Trochanter IV without tubercles.

**Colour:** Spines and transverse granular lines on body, yellowish. Remainder of body dark brown. Legs and pedipalp dark brown. Chelicerae yellow. Eye mound dark brown. Eyes with black centre surrounded by a light area, which again is surrounded by a dark area.

**Measurements:**

| | Body .. | | .. | Length 2.15 | | Width 1.5 | | |
|---|---|---|---|---|---|---|---|---|
| | Cox. | Troch. | Fem. | Pat. | Tib. | Met. | Tars. | Total. |
| Leg I | .5 | .25 | .8 | .3 | .8 | 1.25 | 2.0 | 5.9 |
| Leg II | .55 | .25 | 2.25 | .75 | 2.5 | 2.25 | 5.0 | 13.55 |
| Leg III | .6 | .2 | 1.2 | .45 | .8 | 1.45 | 2.25 | 6.95 |
| Leg IV | .75 | .25 | 2.0 | .45 | 1.25 | 2.5 | 1.75 | 8.95 |
| Pedipalp | .25 | .35 | .65 | .3 | .4 | | .7 | 2.65 |

Chelicera .. Basal .5 Second .7 Total 1.2

*Type:* Auckland Museum Coll.

*Localities:* The species is based on a single specimen collected by Mr. E. G. Turbott on Great Island, Three Kings.

## SUB-ORDER LANIATORES.

## FAMILY TRIAENONYCHIDAE.

## SUB-FAMILY ADAEINAE.

### Genus TRIREGIA n. gen.

Eye mound removed from the anterior margin of cephalothorax by nearly its own diameter, with one anterior-median and one posterior-median large erect and blunt spine. Tergites I-V fused, areas distinguished by transverse grooves which do not reach the sides. Area II and area IV each with median pair strong spines. Anterior margin of cephalothorax strongly armed with forwardly projecting spines. Area V and free tergites I-III each with transverse row of strong spines. Sternites smooth. Sternum narrowly triangular. Chelicerae small, weak, covered with a number of setose tubercles. Pedipalps strong, as long as body, armed below with strong spines.

Coxa I below with numerous spines. Coxae II-IV below with low tubercles. Tarsal segments 3, 7-8, 4, 4.

Distitarsal segments of legs I and II: 2, 3.

Side branches on claws of legs III and IV very small, branching from halfway. Spiracle opening hidden.

Genotype *T. monstrosa* n. sp.

**Triregia monstrosa** n. sp. **Pl. 61, figs. 7-11.**

**Body:** Entire dorsal surface with small papillae placed in a nearly regular pattern (Fig. 7). Eye mound bluntly conical, separated by its diameter from the anterior margin of the cephalothorax, armed along the median line with two strong, erect, blunt spines; one rising anterior to, and one posterior to, the eyes. Eyes placed on outer side of eye mound and directed laterally. Anterior margin of cephalothorax with strong transverse ridge along which are nine spines. Median large, flanked by two small, and a further two large, spines on each side. The row of spines is extended immediately behind ridge by further large spine on each side. There is a further small spine at each anterior corner. On each posterior corner of the cephalothorax is a single large laterally directed spine. Areas I-V distinguished by definite transverse grooves which reach two-thirds across on each side to a pronounced longitudinal groove, which cuts off an unsegmented lateral margin. Lateral margin with two small spines, one at one-seventh, the other at one-third down.

Area I with a median pair of strong erect conical spines, flanked on each side by a smaller spine. Area II without spines. Area III with a median pair of spines of similar appearance to Area I but closer together. Area IV without spines. Area V with large single median spine, flanked on each side by a row of three small spines.

Free tergites 1 and 2, each with a transverse row of seven spines. Free tergite 3 with transverse line of three spines. Sternites smooth, not spined. Sternum as in fig. 10.

Genital operculum with number of small setose tubercles.

**Chelicerae:** Short and weak. Basal segment with one median dorsal and a transverse dorsal distal row of five setose tubercles. Second segment uniformly covered with small low setose tubercles.

**Pedipalp:** Coxa below with a number of low tubercles. Trochanter below with two outer and one inner spine. Inner and outer lateral surface with number of small tubercles. Femur below with outer row of five sharp spines followed by two small blunt spines. Inner surface with row of seven strong spines. Median dorsal row of five blunt spines and a number of small blunt spines on the outer lateral surface.

Patella constricted proximally and strongly curved; one outer distal spine; inner margin with two spines; dorsal surface covered with low tubercles. Tibia below with three outer spines and two inner and dorsal surface with numerous low tubercles. Tarsus below with three outer spines and three inner sharp spines. Terminal claw large and curved.

**Legs:** Coxa of leg I with numerous sharp spines below; trochanter below with two strong spines; femur below with proximal row of three strong and one small spines above with median line of six small setose tubercles, remaining segments free from spines and tubercles. Coxa of leg II below with numerous low tubercles and large blunt spine at posterior distal corner; trochanter with two spines along posterior margin,

and a number of small tubercles on the ventral surface; remaining segments free from spines and tubercles. Coxa of leg III with row of small tubercles on anterior and posterior margins; trochanter with several small tubercles below and single larger one on anterior distal corner. Femur with two small setose tubercles on the proximal outer margin. Remaining segments free from spines and tubercles.

Coxa of leg IV very large, smooth below, anterior and posterior margins each with row of small tubercles. Anterior distal margin with row of three small spines followed by single large spine. Anterior margin of trochanter with one spine at half-way and one at distal corner. Remaining segments free from spines and tubercles.

Calcaneus small.

Tarsal segments: 3, 7, 4, 4.

Distitarsal segments of legs I and II: 2, 3.

Side claws small, branching off median claw at half-way.

**Measurements:**

| | Body | .. | .. | Length 7.1 | | Width 5.2 | | |
|---|---|---|---|---|---|---|---|---|
| | Cox. | Troch. | Fem. | Pat. | Tib. | Met. | Tars. | Total. |
| Leg I | 1.5 | .4 | 3.5 | .6 | 1.7 | 3.0 | 1 0 | 11.7 |
| Leg II | 2.0 | .6 | 5.5 | 1.0 | 4.5 | 5.0 | 1.0 | 19.6 |
| Leg III | 2.4 | .6 | 4.6 | 1.0 | 3.0 | 5.0 | 1.2 | 17.8 |
| Leg IV | 2.7 | .8 | 6.1 | 1.0 | 4.0 | 8.0 | 1.2 | 23.8 |
| Pedipalp | .7 | .7 | 2.5 | 1.3 | 1.7 | | 1.0 | 7 9 |

Chelicera .. Basal 1.4 Second 1.3 Total 2.7

*Type:* Auckland Museum Collection.

*Paratype:* Dominion Museum Collection. Tube 2/61.

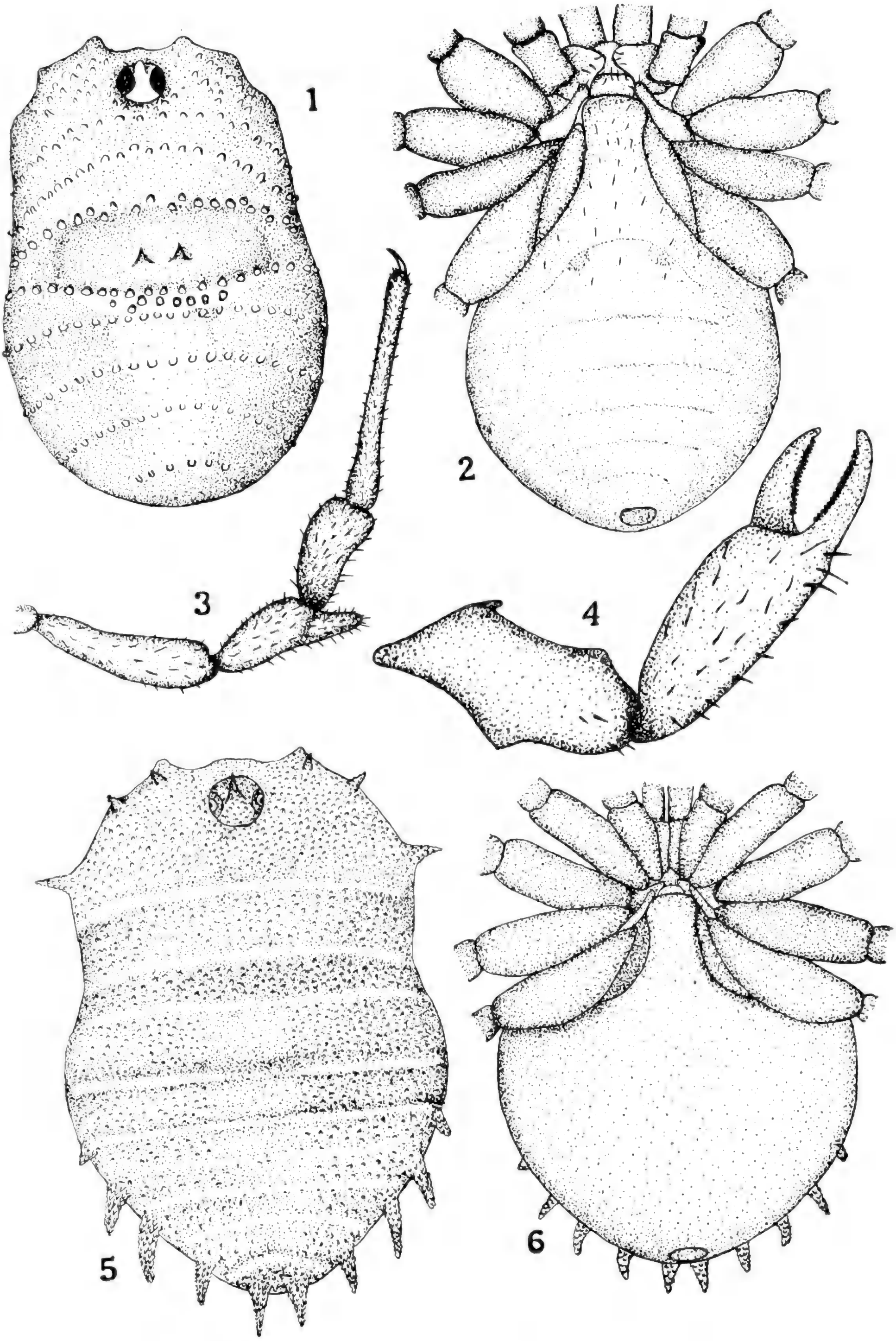
*Locality:* Three specimens collected by Mr. E. G. Turbott from Great Island under stones.

**Triregia bilineata (Forster).**

**Adaeum bilineata Forst., 1943.**

The above species was originally described under *Adaeum* Karsch. It undoubtedly is congeneric with *T. monstrosa,* from which it may be distinguished by its smaller size, presence of a median pair of spines on area IV, and different spination of the pedipalp.

This species was recorded from Whangarei.



Figs. 1-4 *Monoscutum titirangiensis* n. sp.
Fig. 1 Dorsal view of body with appendages omitted.
Fig. 2 Ventral view of body.
Fig. 3 Pedipalp, inner surface.
Fig. 4 Chelicera, outer surface.
Figs. 5-6 *Acihasta salebrosa* n. sp.
Fig. 5 Dorsal view of body, with appendages omitted.
Fig. 6 Ventral view of body.

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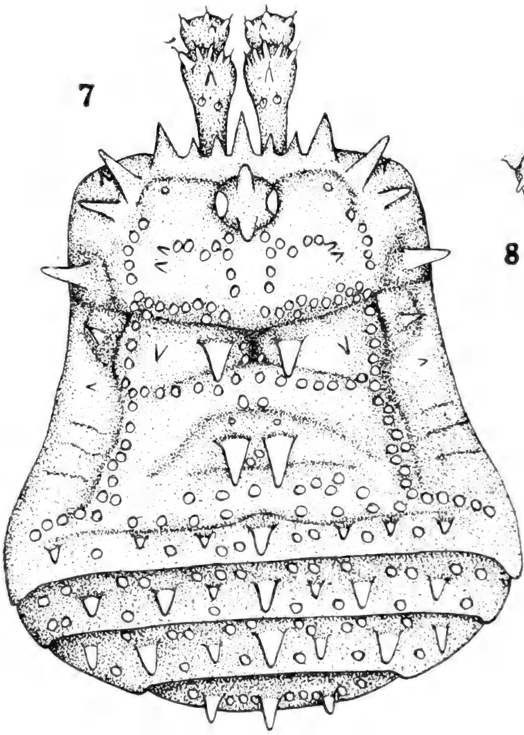

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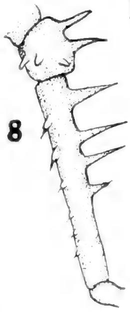

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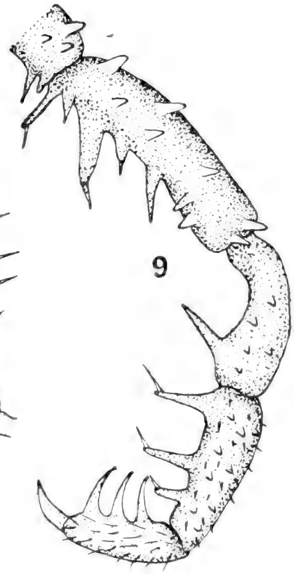

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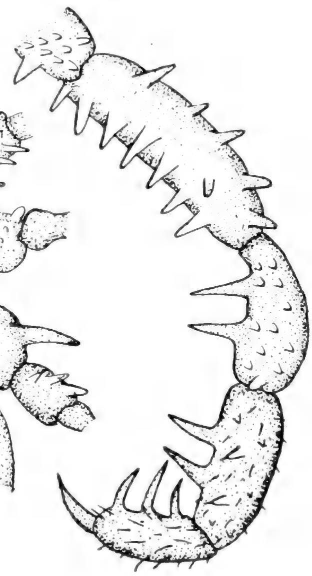

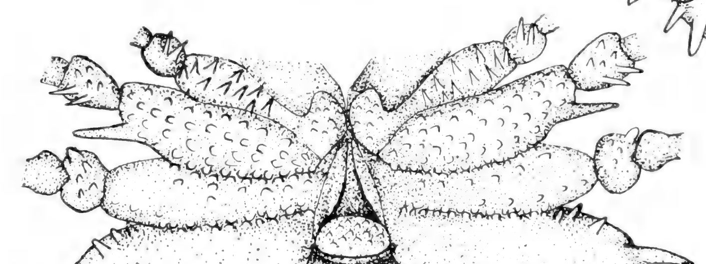

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Figs. 7-11 *Triregia monstrosa* n. sp.
Fig. 7 Dorsal view of body and chelicerae.
Fig. 8 Antero-lateral view of trochanter and femur of leg I.
Fig. 9 Outer view of pedipalp.
Fig 10 Ventral aspect of the anterior portion of body.
Fig. 11 Inner view of pedipalp.

# Birds of the Three Kings Islands

By E. G. TURBOTT, M.Sc., Ornithologist and Entomologist, and G. A. BUDDLE, Associate Ornithologist.

The field notes and collections upon which this paper is based are mainly the result of four recent visits to the Three Kings group: the Auckland Museum Expedition in H.M.N.Z.S. "Arbutus" from 30th November to 6th December, 1945, which included G. A. Buddle, P. C. Bull, and R. A. Wilson; the Department of Internal Affairs Expedition from 13th April to 16th May, 1946, accompanied by E. G. Turbott; and two brief visits in January, 1947, and December, 1947-January, 1948, by G. A. Buddle and M. E. Johnson. The longer of these expeditions visited only Great Island, but on the two last, landings were achieved on the forbidding outliers, North East and South West Islands. We are grateful to all these observers for co-operation in preparing this account, in a number of cases notes being quoted directly over initials. The Museum is indebted to the Hon. Minister of Internal Affairs for permission to collect a small number of specimens on Great Island.

There have been few accounts of the birds of the Three Kings since T. F. Cheeseman visited Great Island in August, 1887, and both Great Island and South West Island in November, 1889 (Cheeseman, 1888 and 1891; Smith, 1887).

From 12th to 15th December, 1928, W. M. Fraser was a member of Lady Alice Fergusson's party camping on Great Island and recorded brief observations on the birds (Fraser, 1929).

A more recent visit was on 20th and 21st February, 1934, when the Auckland Museum Expedition in the auxiliary yacht "Will Watch," including R. A. Falla, W. R. B. Oliver, C. A. Fleming and E. G. Turbott, landed on Great Island. We are grateful to Dr. R. A. Falla for checking references to this visit, and for the opportunity to refer to his manuscript for this series (Falla, 1948).

## ECOLOGICAL AND DISTRIBUTIONAL NOTES.

The Three Kings Islands lie thirty-five miles beyond the northern point of New Zealand. Precipitous coasts, strong tidal currents and the heavy swell of the Tasman Sea all contribute to the inaccessibility of the group. The islands lie east and west in a serrated line, Great Island, approximately 1,000 acres in area, being flanked by two much smaller members, North East and South West Islands; westwards again, the rocky chain of the Princes Islands terminates in a third, and as yet unexplored outlier, West Island.

The four larger islands were originally richly clothed in mixed coastal or semi-coastal forest (Baylis, 1948); and North East, South West and West Islands are still covered, except on the most rocky cliffs, by dense forest and scrub. The vegetation of Great Island forms a

marked contrast, having undergone profound changes during early Maori settlement and later as the result of the influence of goats (Baylis, ibid.)

In 1946, when the goat population was exterminated, the plant covering of Great Island consisted almost entirely of a uniform forest composed of *Leptospermum ericoides* A. Rich. (kanuka), the monotony of which was scarcely broken by a few scattered, large-leafed trees. This *Leptospermum* forest was open and park-like, being almost devoid of undergrowth, but on the forest floor sedges, grasses, and herbs formed a dense mat broken at intervals by patches of short, dry turf. The only part of the island not invaded by *Leptospermum* forest was a comparatively small area of grassland and adjoining wind-swept prostrate *Leptospermum* scrub on the southern slopes of Tasman Valley.

The deep-seated effect of these environmental modifications upon the birds of Great Island is discussed elsewhere (Turbott, 1948). The impoverishment of the vegetation by goats is considered to have been the primary factor contributing to the present low population densities of all the endemic land birds except one abundant species, *Anthornis melanura* (Turbott, 1940 and 1948). Competition by nine species of naturalised passerine birds which have reached Great Island is not regarded as of marked effect, nor is the influence of the two predatory species, *Ninox novaeseelandiae* and *Circus approximans*.*

Great Island would appear (Turbott, 1948) to have supported originally a much richer land bird fauna. Some species must have become extinct during Maori occupation, and others more certainly during the period when goats progressively reduced the vegetation. Re-establishment of these species from the mainland, although in most cases within their possibilities of dispersal, had apparently been impossible on account of the modification of the plant covering. The following species are believed with reasonable certainty to have occurred formerly on the island: *Bowdleria punctata*, *Pseudogerygone igata* and *Prosthemadera novaeseelandiae*, listed from Great Island by Cheeseman (1888) in 1887; and *Cyanoramphus auriceps*, recorded during the "Will Watch" Expedition in 1934. In addition, *Cyanoramphus novaezelandiae* appears to have suffered a considerable population decrease since the latter visit.

Changes in the vegetation and direct trampling and disturbance by goats are believed to have influenced the extent and location of breeding colonies of petrels and of *Larus novaehollandiae* (Turbott, 1948).

It will be evident from this brief reference that, as regeneration of the vegetation proceeds, study of the birds of Great Island will be of the greatest interest, especially as regards the possibility of modification in habits and population densities, and of recolonisation by species from the mainland.

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* Naturalised predatory mammals are absent from the Three Kings.

The land bird fauna of the group, as known from historical and recent accounts, evidently closely resembles that of the mainland; but endemism has developed in *Anthornis melanura,* described as a distinct subspecies by Falla (1948), and may be incipient in a mutant element which we record in discussing the population of *Rhipidura fuliginosa.*

As a breeding centre for sea birds in this region the Three Kings are of major significance: *Pelecanoides urinatrix, Puffinus gavia, Pterodroma macroptera, Morus serrator* and *Larus novaehollandiae* all breed on the group in large numbers. An unexpected addition to the list of sea birds breeding on Great Island is *Pterodroma hypoleuca nigripennis,* of which a small breeding colony was discovered during the "Arbutus" Expedition in 1945. The range of this species is thus further extended, Falla (1942) having identified skins from Lord Howe Island as of this species.†

**Breeding seasons.** Bull (1946) has referred to the breeding season of *Turdus merula* as observed on Great Island in November-December, 1945, remarking that slightly later breeding dates distinguish this species on Little Barrier and the Poor Knights, as well as on the Three Kings. This is attributed to the necessarily more shaded habitat on such islands, which are covered by bush or scrub. Bull further suggests that this species may have a relatively late breeding season in forest habitats elsewhere in New Zealand, as indicated by observations in the Rotorua district.

During the "Arbutus" Expedition the possibility of a general retardation of the breeding season on the Three Kings became evident. This is indicated by later breeding dates for sea birds—*Larus novaehollandiae, Pelecanoides urinatrix* and *Puffinus gavia*—as compared with observations on the Mokohinau group in the same year, and on the Poor Knights in 1940 (Buddle, 1941, 1946, 1947; Fleming, 1946).

Further research would be of value on the breeding seasons of both land and sea birds on northern offshore islands.

## SYSTEMATIC LIST.

### Eudyptula minor (Forst.) (little blue penguin).

**Great I.:** The blue penguin has not been recorded as breeding, but rock crevices in North West Bay were found to contain feathers on 21st February, 1934, probably where the birds had come ashore to moult.

### Pelecanoides urinatrix (Gm.) (diving petrel).

**Great I.:** Fraser (1929) describes "two fairly large colonies" and records a half-feathered chick found under a box above South East Bay (12th-15th December, 1928); this record being listed by Oliver (1930) and mentioned by Falla (1934). In November-December, 1945, the diving petrel was found nesting in considerable numbers on the eastern coast and in Tasman Bay. In November, 1945, two burrows were found, each with an adult or an egg (P.C.B.) but otherwise the burrows commonly contained chicks in dark grey down. In April-May, 1946, a

† Previously recorded breeding on the Kermadec and Austral groups.

few diving petrels were coming in, generally silently, at night with the other petrels; and were observed offshore in twos and threes. **South West I.:** Buddle (1948) records young in burrows on 3rd January, 1947.

**Pelagodroma marina (Lath.) (white-faced storm petrel).**

**Great I.:** This must be regarded as a tentative addition to the breeding list, on the evidence of a leg found in a nest of *Ninox novaeseelandiae* on 1st December, 1945. This species was seen off West Island on 6th December, 1945 (G.A.B.).

**Puffinus carneipes Gould (flesh-footed shearwater).**

Recorded from the Three Kings by Oliver (1930), and stated to be probably breeding by Falla (1934); but not found during recent visits. Flesh-footed shearwaters were observed offshore in considerable numbers on 31st December, 1947; particularly near the still unexplored West Island (G.A.B.).

**Puffinus bulleri Salvin (Buller's shearwater).**

Falla (1934) considers it extremely probable that Buller's shearwater breeds on the group: it has been observed commonly offshore during all recent expeditions, one being recorded as late as April, 1946 (E.G.T.), but breeding has still to be recorded.

**Puffinus griseus (Gm.) (sooty shearwater).**

**Great I.:** Falla (1934) records this species as breeding: an adult was found in a burrow above North West Bay on 21st February, 1934. On 3rd December, 1945, one was seen on the ground at night (P.C.B.); and a well-fledged young shearwater found in a burrow on 14th April, 1946 and described by M. Chaney was probably of this species. As on other northern offshore islands, the Three Kings breeding population is probably small.

Sooty shearwaters were observed off West Island on 6th December, 1945 (G.A.B.).

**Puffinus gavia (Forst.) (fluttering shearwater).**

**Great I.:** This was found to be the commonest breeding petrel during recent expeditions. It is recorded from the Three Kings by Falla (1934): empty burrows and a dead specimen were found on Great Island and the birds heard at night over North West Bay, 20th-21st February, 1934. In November-December, 1945, the fluttering shearwater was found nesting on many parts of the island, occurring in the greatest numbers above the eastern and northern coasts, and in Tasman Bay. Of those examined at this time at least half contained chicks. The incoming birds were particularly noisy, their staccato calling being continuous from about 8.30 p.m. They were observed squatting, sometimes in pairs, outside the burrows (P.C.B.). In April-May, 1946, this species was still coming in, although the young would have departed towards the end of January (Falla, ibid.). It would thus appear to visit the breeding stations for some months after the young have left, in this habit resembling *Puffinus assimilis* and *Pterodroma macroptera* (Fleming and Serventy, 1943); like these two species the fluttering

shearwater is non-migratory. **South West I.:** Buddle (1948) describes many burrows containing young on 3rd January, 1947. **North East I.:** Young were found on 4th January and 31st December, 1947 (G.A.B.).

**Puffinus assimilis** Gould (allied shearwater).

**Great I.:** On 1st December, 1945, freshly-vacated burrows were examined above Tasman Bay, feathers and the size of the burrows suggesting that they were of this shearwater. **South West I.:** Cheeseman (1891) states that a specimen (? adult or young) was taken from a burrow among roots of *Meryta sinclairii* (Hook. f.) Seem. (puka) in November, 1889. The bird was apparently not collected, there being no specimen with these data in the Auckland Museum. Fleming and Serventy (1943) regard as doubtful Mathews' reference (1934) to this species from the Three Kings, which is listed by Oliver (1930). It seems possible, in view of the discovery of *Puffinus gavia* on the same island, that Cheeseman's identification may have been in error, although the presence of an adult allied shearwater ashore in November is comparable with Major R. A. Wilson's record on Hen Island (Falla, 1934; Fleming and Serventy, 1943).

**Pterodroma macroptera** (Smith) (grey-faced petrel).

**Great I.:** The grey-faced petrel nests in considerable numbers; records of breeding behaviour on the Three Kings corresponding closely to Falla's general account of this species (1934). On 29th-30th November, 1945, two nests examined each contained a fully-fledged chick; and a few adults were seen on the ground at night (P.C.B.). In April-May, 1946, this was the principal petrel coming in, making a dramatic landfall in erratic flight especially on the saddle between North West Bay and South East Bay. Calling began before dark, particularly on clear nights, the birds being seen circling close overhead shortly after 6 p.m. On cloudless nights they were quite silent by 9.10 p.m., but on overcast nights or in rain were heard until much later. Calling was accompanied by chasing flights. On 19th April, 1946, several burrows examined during the day contained single birds or pairs. **South West I.:** Buddle (1948) records fully fledged young on 3rd January, 1947; a number of unoccupied burrows were considered to be of this species. **North East I.:** Many burrows, apparently of this species, were unoccupied on 30th December, 1947 (G.A.B.).

**Pterodroma hypoleuca nigripennis** (Rothschild) (black-winged petrel).

**Great I.:** This record of the black-winged petrel within New Zealand was made by Mr. P. C. Bull on 3rd December, 1945. At the eastern point of the island shortly after sunset, Mr. Bull saw medium-sized petrels with white underparts by torchlight, but none were observed to land until about 9.30 p.m. Their flight was most erratic, frequently with chasing in pairs. A shrill piping and a moaning note were produced in the air, but on the ground only a croaking note. Altogether, at least twelve pairs were observed and others heard in the same area.

The discovery was made just before the end of the visit, so that no further observation was possible.

Mr. Bull's field recognition of these birds, together with the following live measurements* of eight individuals, leave no doubt as to the identity of this petrel: (in m.m.)

| No. | Sex | Locality | Date | Wing | Tail | Tarsus | Toe | Culmen |
|---|---|---|---|---|---|---|---|---|
| A | — | Great I., Three Kings | 3/12/45 | 226 | 101 | 32.5 | 37 | 24 |
| B | — | Great I., Three Kings | 3/12/45 | 230 | 105 | 33 | 38 | 24 |
| C | — | Great I., Three Kings | 3/12/45 | 223 | 103 | 33 | 36 | 25.5 |
| D | — | Great I., Three Kings | 3/12/45 | 230 | 107 | 33 | 39 | 24 |
| E | — | Great I., Three Kings | 3/12/45 | 228 | 107 | 32 | 38 | 25 |
| F | — | Great I., Three Kings | 3/12/45 | 227 | 106 | 32 | 38 | 24 |
| G | — | Great I., Three Kings | 3/12/45 | 227 | 107 | 32 | 37 | 24 |
| H | — | Great I., Three Kings | 3/12/45 | 230 | 106 | 31 | 37 | 25 |
| AM. 137.2 | ♀ | Kermadec Is. | — | 228 | 103 | 29 | 37 | 25 |
| 137.3 | — | Curtis I., Kermadecs | Nov. 1890 | 228 | 104 | 28.5 | 36 | 23 |
| 137.4 | ♀ | Kermadec Is. | 19/2/09 | 230 | 104 | 30 | 35 | 24 |
| 137.5 | ♀ | Kermadec Is. | 9/1/09 | 228 | 106 | 29 | 35 | 23 |
| 137.6 | ♂ | Kermadec Is. | Jan. 1909 | 228 | 104 | 30 | 37 | 23.5 |
| 137.7 | — | Curtis I., Kermadecs | Nov. 1890 | 224 | 100 | 30 | 36 | 24 |
| 137.8 | ♀ | Kermadec Is. | — | 223 | 103 | 33 | 39 | 24 5 |
| 137.15 | ♂ imm. | Curtis I., Kermadecs | 16/4/29 | 205 | 103 | 32 | 38 | 25 |
| 137.16 | ♂ | Kermadec Is. | 19/2/09 | 226 | 102 | 31 | 36 | 23.5 |

Mr. Bull's field notes include the description of the feet as "pale vinaceous grey, outer toe and distal half of web and remaining toes black." Photographs were taken in the field by G. A. Buddle.

On the Kermadecs Oliver (1930) describes this petrel as being first heard late in October and coming ashore to clean the burrows in mid-November; the eggs are laid in late December and early January. These dates correspond with Mr. Bull's observations of behaviour, including mating flights, in early December. The opportunity may be taken to note that on 4th December, 1907, G. A. Buddle found a pair ashore in an empty burrow on Curtis Island of the Kermadec group.

On 19th April, 1946, small burrows examined in the eastern area of Great Island had apparently been recently vacated, containing white feathers, eggshell and much nesting material; in some cases the burrow entrance appeared to have been recently scraped (E.G.T.). These burrows, if of the present species, would correspond to Oliver's record of the departure of the young on the Kermadecs in April. It is of interest that two immature specimens in Auckland Museum were collected on Curtis Island of the Kermadecs by A. T. Pycroft on 16th April: A.M. 137.15, tabulated above, is fully fledged with down still adhering to the neck, and A.M. 137.14 is a well-feathered chick with much down remaining on the underparts and scattered dorsally. Mr. A. T. Pycroft informs us that both were collected in the burrow. Undiscovered burrows on Great Island may still have contained young at this stage on 19th April.

* As Fleming (1941) states, culmen length is essentially the same in live birds and dry skins, other dimensions not requiring any significant reduction.

The discovery of the black-winged petrel on the Three Kings during the "Arbutus" Expedition is mentioned in an editorial paragraph in "New Zealand Bird Notes" (vol. 2, p. 11), with reference to a photograph published in the "Auckland Weekly News."

**Pterodroma** sp.

Characteristic "ti-ti" calls of some species of gadfly petrel, as distinct from any sound known to be made by *Pterodroma h. nigripennis,* were heard regularly on Great Island in November-December, 1945. The calls appeared to come from one or two birds flying above the peak eastwards from the depot.

**Phalacrocorax varius (Gm.) (pied shag).**

This species was recorded somewhat indefinitely offshore in April-May, 1946; on 3rd January, 1948, three were seen (G.A.B.) in flight between Great and South West Islands.

**Morus serrator (Gray) (gannet).**

A full account of gannet colonies on the Three Kings as observed on 3rd-6th January, 1947, has been published by G. A. Buddle (1947). The population is a large one, being given on the basis of combined estimate and count as 3,750 birds. Of these, 750 are regarded as being from South West Island, where 250 nests, eggs and young were counted, and the remainder from four members of the Princes Islands.†

The colony on the south-eastern point of South West Island was examined in November, 1889, by Cheeseman (1891), who describes gannets and red-billed gulls together as numbering "thousands." The gannet colony was inshore from that of the gulls and of much larger extent; eggs were just beginning to hatch, and plenty of young were seen, at the slate-coloured stage and without down.

It is difficult from Cheeseman's description to judge whether any change has occurred in this colony since 1889, although his general statement of numbers and area would suggest that the colony has decreased considerably. Buddle (1947) gives reasons for believing that it is expanding at present into the neighbouring scrub.

In April-May, 1946, gannets could be seen from Great Island still in occupation of the South West Island colony.

**Sterna striata Gm. (white-fronted tern)**

This species was seen offshore in November-December, 1945, but has not been recorded as breeding on the group.

† G. A. Buddle (*New Zealand Bird Notes,* 3, 40; 1948) summarises observations made on South West Island and the Princes on 1st January, 1948. Closer and more detailed observation indicates that the total population of gannets is probably c. 5,500. Some of the smaller isolated colonies had increased in size since January, 1947.

**Larus novaehollandiae** Steph. (red-billed gull).

The Three Kings form perhaps the largest breeding station in New Zealand for the red-billed gull. Cheeseman (1891)‡ in his account of South West Island refers to a nesting colony of thousands, and Fraser (1929) estimated tens of thousands breeding in many separate colonies on Great Island, more especially above South East Bay (12th-15th December, 1928). Fleming (1946) mentions the major proportions of the colonies as indicated by observations during the "Will Watch" Expedition; during this expedition (20th-21st February, 1934) breeding was still in progress at South East Bay, Crater Head and on the eastern coast. **Great I.:** Some of the many colonies round the cliffs examined in detail during the "Arbutus" Expedition from 30th November to 6th December, 1945, included c. 300 above Tasman Bay, and c. 500 nests on the east coast. Of 100 nests counted on 3rd December in the latter colony, one contained three, 67 two, and 32 one egg; four or five empty nests were counted (P.C.B.). No young were seen during this visit. In April-May, 1946, flocks were seen feeding offshore, but the nesting areas were now completely deserted. Considerable numbers in immature plumage were found dead, 20-30 being counted in one day on the western portion of the island. **South West I.:** Buddle (1947, 1948) describes a large colony of several thousands, corresponding to Cheeseman's description, at the south-eastern end of the island on 3rd January, 1947, less than one per cent of the eggs having hatched on this date. The adults were feeding on the fruits of *Meryta sinclairii*, a habit referred to by Baylis (1948) in describing the regeneration of the vegetation on Great Island. **Princes Is.:** Large colonies existing on these rocks are described by Buddle (1947, 1948).

This species does not breed on North East Island and West Island (G.A.B.).

On 21st February, 1934, vast massed flocks of this gull, with *Puffinus gavia*, swirled about the "Will Watch" to the north of the group (Falla, 1934); smaller flocks have been seen feeding offshore in November-December-January during recent visits.

**Larus dominicanus** Lich. (black-backed gull) has never been recorded, although it is common on the nearby mainland. Murphy (1936) states that this gull seems to be particularly dependent upon local conditions in its breeding range in South America. The combination of rigorous littoral conditions and competition by other species may make for an unsuitable habitat on the Three Kings.

**Hypotaenidia philippensis** (L.) (banded rail).

**Great I.:** One specimen, A.M. 57.42, an adult male, 4/12/45, is not different from mainland specimens. The banded rail is recorded by Fraser (1929), who recognised the call. It has been observed on subsequent visits, being apparently sparingly distributed over the whole island. It feeds in the open forest, amongst the sedges and other ground vegeta-

‡ Cheeseman mentions that fresh eggs were eaten by the crew of the "Hinemoa" (November, 1889).

tion. A pair, or possibly three, were constantly seen near the depot in April-May, 1946; two calls familiar on the mainland, a purring note and a sharp pipe, were heard.

**Porzana tabuensis** (Gm.) (spotless crake).

**Great I.:** The crake was recorded during the "Arbutus" Expedition, being glimpsed doubtfully, and heard on one occasion. On 18th April, 1946, during shooting, one was seen clearly near the western cliffs, being frightened from cover in low scrub and sedge; it gave a high-pitched alarm note as it ran across an open space (E.G.T.). **South West I.:** Buddle (1948) on 3rd January, 1947, found this species fairly plentiful and discovered one empty nest.

The ecological requirements of these two species of rail on offshore islands are difficult to determine. *Hypotaenidia philippensis* would appear to have replaced *Porzana tabuensis* under the open *Leptospermum* forest of Great Island; and predominates on Tawhiti Rahi of the Poor Knights group, where both are present (Buddle, 1946). This species is absent from Aorangi of the same group, but here *Porzana* is common, a fact believed by Buddle (1941, 1946) to depend partly upon the abundance of the native grass *Microlaena polynoda* Hook. f., which provides a favoured nesting site. On South West Island *Porzana* is a breeding species, possibly with a similar relationship to the ground vegetation. Apart from a nesting association with the vegetation, *Porzana* would appear to thrive on smaller islands with a dense covering of forest of scrub; while any considerable modification as on Great Island, or on Tawhiti Rahi, of which a small part has been burned, is apparently favourable to *Hypotaenidia*. The powers of dispersal of rails in general are such that the distribution of these species on northern offshore islands must depend upon factors other than geographical.

**Porphyrio poliocephalus** (Lath.) (pukeko).

**Great I.:** A skeleton of an adult with feathers still attached, A.M. 64.42, was found above Tasman Bay on 28th April, 1946. This species is a straggler to the Kermadecs (Oliver, 1930) and to Lord Howe Island (Hindwood, 1940).

**Synoicus** sp. (brown quail).

**Great I.:** The following four skins are in the Auckland Museum:

| No. | Sex | Date | Wing | Tail | Tarsus | Toe | Culmen |
|---|---|---|---|---|---|---|---|
| A.M. 890.10 | ad. ♀ | 30/11/45 | 100 | 50 | 22.5 | 27 | broken |
| 890.11 | ad. ♂ | 30/11/45 | 99 | 50 | 22 | 27 | 14 |
| 890.15 | ad. ♂ | 14/ 5/46 | 97 | 47 | 24 | 27 | 15 |
| 890.16 | ad. ♀ | 14/ 5/46 | 99 | 48 | 23 | 26 | 14 |

The measurements, colour of soft parts, and plumage characters of this small sample correspond to those of brown quail at present occurring near Auckland.

We have at the suggestion of Dr. R. A. Falla left open the identity of quail on the Three Kings until further investigation has been carried out. We are indebted to Dr. Falla for permission to refer to his sug

gestion that before the introduction of *Synoicus ypsilophorus* (Bosc.) from Australia, an indigenous *Synoicus* may have existed in the northern New Zealand region, including the offshore islands (see Thomson, 1922; Buddle, 1941, 1946). The indigenous quail may itself have been a subspecies of *Synoicus ypsilophorus*.

Both *S. y. ypsilophorus* and *S. y. australis* (Lath.) were released near Auckland between 1867 and 1871 (Thomson, 1922), and could conceivably have reached the Three Kings by the time of Cheeseman's visit in 1887; furthermore, it seems probable that brown quail from the mainland at present regularly reach at least the nearer offshore islands (Turbott, 1947).

Cheeseman (1888 and 1891) first recorded the quail on Great Island, referring it to *Coturnix novaezealandiae* Q. & G. on field identification. It was not regarded as common, only three being seen in 1887 and 13-14 in 1889. Cheeseman's record in 1887 is mentioned by Buller (1888). In November, 1889, a "beautifully-made, cup-shaped nest" containing six fresh eggs was found: these were brought back for the Auckland Museum, but are not now in the collections; one was given to Buller, who recognised it as "not that of our New Zealand Quail, but of *Synoecus australis*, the Brown Quail of Australia, which has been introduced into New Zealand, and is now extremely plentiful in all parts of the country" (Buller, 1905).

Fraser (1929) found the quail, which he referred to as *Coturnix novaezealandiae*, on every part of the island, and saw young not long hatched, 12th-15th December, 1928. It is interesting that the call is described by Fraser as "whe-whi," a good rendering of the common call of *Synoicus ypsilophorus*. Oliver (1930) subsequently referred quail on the Three Kings to *Synoicus australis* (Lath.).

On recent visits the quail has been found to be quite common. It occurs in small flocks on the open forest floor, probably obtaining abundant insects and fruits of grasses and sedges. The drawn-out call described by Fraser is heard frequently, and a sparrow-like chirping given when flying away upon being disturbed. Two nests containing nine and fifteen eggs respectively were found on 2nd and 5th December, 1945; and newly hatched chicks were seen on 3rd December.

**Circus approximans** Peale (harrier).

**Great I.:** Cheeseman (1888), Oliver (1930); noted as absent by Fraser (1929). A few have been observed on all recent visits, including a record by Johnson (1946). On 1st December, 1945, a nest containing four eggs was found on a platform of wind-swept *Leptospermum*. **South West I.:** Cheeseman (1891) discovered a nest containing fledglings nearly full grown. One was seen circling the summit on 3rd January, 1947 (G.A.B.).

**Ninox novaeseelandiae (Gm.)** (morepork).

**Great I.:** Cheeseman (1888), Fraser (1929), Oliver (1930). The morepork is in moderate numbers; food is plentiful, comprising mainly brown geckos (*Hoplodactylus spp.*) and numbers of *Anthornis melanura*, remains of which were found near the nests (P.C.B.). Three

nests were discovered on 1st December, 1945, the first containing two newly-hatched chicks, the second fully-fledged young, and the third an infertile egg and young bird half grown. The situation was in all cases on the ground, under cover of a cavelet or at the base of a hollow tree. Crevices in inland rocks were common daytime roosting places; both "more-pork" and scream, the common calls on the mainland, were heard. **South West I.:** Several were seen by Cheeseman (1891); not recorded on 3rd January, 1947 (G.A.B.).

**Cyanoramphus novaezelandiae** (Sparrm.) (red-fronted parakeet)

**Great I.:** Two skins in the Auckland Museum have the following data and measurements:

A.M. 42.20, 20/2/1934, male (immature?), wing 134, tail 141, tarsus 19, toe 25, culmen 18.

A.M. 42.21, 20/2/1934, female (immature?), wing 124, tail 123, tarsus 19, toe 25, culmen 14.

Recorded by Cheeseman (1888); Fraser (1929); Oliver (1930). This parakeet was regarded as moderately plentiful during the "Will Watch" Expedition in 1934. On recent expeditions, including a visit by M. E. Johnson on 1st January, 1945 (Johnson, 1946), it has been observed only occasionally, and would certainly appear from general observation to have decreased in numbers (E.G.T.). Its breeding habits have not been observed on the group. **South West I.:** Buddle (1948) refers to numbers representing an established population, January, 1947. **North East I.:** A pair was recorded by Buddle (1948) in January, 1947.

**Cyanoramphus auriceps** (Kuhl) (yellow-fronted parakeet).

This species, which occurs on the larger islands—Hen Island and Little Barrier Island—off the northern coast, was seen on Great Island on 20th February, 1934, close to the castaway depot. One bird was observed closely, and another at some distance; one being recorded again on the following day. The longer periods in 1945 and 1946 would have ensured observation of this species, but it must be regarded as extinct on the island (Turbott, 1948).

**Eudynamis taitensis** (Sparrm.) (long-tailed cuckoo).

**Great I.:** Not more than one or two recorded in February, 1934; and again in December, 1945.

**Halcyon sanctus** V. & H. (kingfisher).

**Great I.:** Two adult male skins, A.M. 29.54 (22/4/46) and 29.55 (13/5/46) fall within mainland series except that in A.M. 29.54 the collar is white. In a series of this species from the mainland in the Auckland Museum the collar ranges from deep buff to pale with only a faint buff wash. The specimen, A.M. 29.54, is referred to in the discussion of *Rhipidura fuliginosa* below. Cheeseman (1888); Fraser (1929); Oliver (1930). The kingfisher occurs only in small to moderate numbers, although it is seen frequently throughout the island. Burrows were found in December, 1945, on the banks of the Tasman Stream, one containing five eggs. **South West I.:** Recorded on 3rd January, 1947 (G.A.B.).

**Anthus novaeseelandiae (Gm.) (pipit).**

**Great I.:** Cheeseman (1888); Fraser (1929); Oliver (1930); Johnson (1946). The pipit is fairly common, inhabiting the rocky seaward faces along the shore, the grassy slopes and scrub of Tasman Valley and, as an additional niche characteristic of this island, the more open parts of the *Leptospermum* forest (Turbott, 1948). It is absent only in groves of mixed forest and tall *Leptospermum* in the deeper Tasman Valley. A nest with four eggs was found on 1st December, 1945. **South West I.:** Buddle (1948) observed a pair in January, 1947, on the grassy summit plateau (G.A.B.).

**Bowdleria punctata (Q. & G.) (fern-bird).**

Listed from Great Island by Cheeseman (1888); Oliver (1930). This species is now absent; it may well have been an inhabitant of tussock and shrubland on Great Island, resembling in this respect fern-birds of the Snares and the Chatham Islands. Cheeseman (1888) records it only in a list, and may possibly have identified it from call alone; in this case the record may be regarded with some doubt. This species is at present common in scrub and fern country on the adjacent mainland (Watt, 1947).

**Pseudogerygone igata (Q. & G.) (grey warbler).**

Listed by Cheeseman (1888 and 1891) from Great Island and South West Island; Oliver (1930). On South West Island Cheeseman found the grey warbler comparatively scarce. It is now absent on Great Island and apparently also on South West Island (G.A.B.) (Turbott, 1948). It is plentiful on the neighbouring mainland (Watt, 1947).

**Rhipidura fuliginosa (Sparrm.) (fantail).**

The following are data and measurements of three skins in the Auckland Museum*:

A.M. 17.26: 5/12/45, Great Island; wing 72, tail 90, tarsus 19.5, toe 13, culmen (broken).

A.M. 17.27: 11/5/46, adult ♂, eastern division of Great Island; wing 73, tail 92, tarsus 19, toe 14.5, culmen 8.5.

A.M. 17.28: 12/5/46, adult ♂, Tasman Valley, Great Island; wing 76, tail 101, tarsus 19, toe 15, culmen 8.

These measurements, and colours of soft parts, show no difference from mainland specimens.

A.M. 17.26 and 17.27 are distinguishable from all "pied" *Rhipidura fuliginosa* from the mainland which we have examined by a particularly wide and distinct band of white-tipped feathers between the black foreneck and the buff underparts; and from freshly moulted mainland specimens by the paler colour of the under surface, which is a yellowish buff.

A.M. 17.28 cannot be separated from mainland specimens, having no white breast band, although there are a few feathers tipped with pale buff along the lower edge of the black foreneck. The under surface in this specimen is a rich warm buff.

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* See Appendix.

In a considerable proportion of our mainland series of "pied" *Rhipidura fuliginosa,* a more or less distinct line of pale buff-tipped feathers delineates the lower edge of the black foreneck, generally affecting not more than two rows of feathers. The character occurs at random in these specimens, collected chiefly in Auckland and Nelson, and remains distinct although the colour of the adjacent under surface may be obscured by seasonal fading or wear.

We note that Mayr (1931) describes as follows the seasonal plumage changes in *Rhipidura fuliginosa brenchleyi* Sharpe, which are probably applicable to all forms of *Rhipidura fuliginosa*: freshly moulted birds are stated to have the underside tinged with a warm ochraceous-buff which bleaches to pale buff later in the season, while the upperside gets a brownish tinge due to wear. It seems probable from the series which we have examined that, apart from this seasonal fading, the depth of colour in the buff underparts varies considerably in this species on the mainland.

Of the specimens from Great Island, both A.M. 17.27 and 17.28 collected in May proved to have well-developed testes (in A.M. 17.28 measuring 1.5 x 1 mm.); and neither shows any sign of moult, wear or fading. In A.M. 17.26, obtained in December, the tail feathers are worn at the tips, so that the under surface might by this time of the year have begun to fade.

Our conclusion as regards these specimens from Great Island is that A.M. 17.26 and 17.27 are mutants, being distinguishable from *Rhipidura fuliginosa* of the mainland by the distinct white band on the upper breast and pale under surface; and that A.M. 17.28 represents an element in the population conforming in colour characters to the mainland range. Unfortunately the necessarily few specimens available are not sufficient to indicate the numerical status of the mutant.

According to our estimate the numbers of this species on Great Island are at present not more than fifty. As indicated above, the population has been subjected to modification of the habitat since early Maori settlement, but to a marked degree for approximately fifty years during which modification by goats is known to have been in progress (Turbott, 1948). Under these conditions, the occurrence of a well-established mutant would be significant as dependent upon the "Sewall Wright effect," whereby small isolated groups of a hundred individuals or less tend towards genetic homogeneity. In such populations mutations may become established by accident alone as true non-adaptive differences (Mayr, 1942; Lack, 1947; Turbott, ms.).

It seems possible that in *Rhipidura fuliginosa* on Great Island the mutant may be replacing the normal phase, in which case the population could be regarded as having reached a stage in subspeciation. *Rhipidura fuliginosa* would appear to be essentially sedentary, although, as Mayr and Moynihan (1946) have shown with reference to *Rhipidura rufifrons,* fantails are capable of widespread dispersal over long periods of time, their apparently weak powers of flight being most deceptive. "Normal" characters may thus have become re-established in this essen-

tially isolated stock through occasional influx from the mainland population. On the neighbouring mainland the fantail is at present plentiful (Watt, 1947).

The mutant of *Rhipidura fuliginosa* and *Anthornis melanura* subsp. nov. (Falla, 1948) are both characterised by the replacement of coloured plumage markings by white; and the same trend towards loss of colour occurs in a single specimen of *Halcyon sanctus* already described. Murphy (1938) draws attention to the difficulty of accounting for cases of convergence in size or colour, which may affect practically all the endemic birds on certain islands.

The call note of fantails on Great Island has been recorded independently by several observers as markedly sharper and more strident than on the mainland. As Falla (1948) indicates with reference to *Anthornis melanura*, insular populations tend to have a distinct song. Further research into the diagnostic value of voice characters in such cases would be of interest.

The fantail was recorded on Great Island by Cheeseman (1888); by Fraser (1929); and listed by Oliver (1930). On 20th February, 1934, during the "Will Watch" Expedition young birds were still readily distinguishable.

**South West I.:** Cheeseman (1891), "comparatively scarce"; not recorded on 3rd January, 1947 (G.A.B.).

**Zosterops lateralis (Lath.) (silvereye).**

**Great I.:** Cheeseman (1888); Oliver (1930). The silvereye has not been recorded during recent expeditions, except on 6th May, 1946, when a flock of 10 to 12 was observed. It seemed evident that these had come from the mainland, their appearance coinciding with a wind change to the south-west, following upon a prolonged period of stormy weather from the east. They may well have been survivors of a larger flock blown westwards from the narrowly attenuated adjacent mainland during the storm; this species is here particularly common (Watt, 1947) and would at this time of the year be moving about in large winter flocks.

The members of the flock observed on Great Island were obviously agitated and particularly noisy, appearing to traverse the island haphazardly without feeding. They were first seen at mid-day, two or three being observed almost simultaneously by members of the party scattered over the island, and the full flock noted together in the evening. They remained on the island until at least 12th May (E.G.T.).

In view of this observation, the possibility arises that Cheeseman's record also refers to stragglers, although, as suggested elsewhere (Turbott, 1948), it was quite probably breeding on Great Island before the vegetation had been modified to its present state.

**South West I.:** Cheeseman (1891) also records the silvereye, noting that it was apparently comparatively scarce. It was not observed during the brief visit on 3rd January, 1947 (G.A.B.) (Turbott, 1948).

**Prosthemadera novaeseelandiae (Gm.) (tui).**

**Great I.:** Cheeseman (1888); Oliver (1930); Johnson (1946) in error (Turbott, 1948). Cheeseman's record of the tui seems likely to be definite, and this species must be added to the list of birds which have become extinct comparatively recently, with the continued modification of the vegetation. On the far northern mainland it occurs only as a straggler (Turbott, 1948).

**Anthornis melanura (Sparrm.) (bellbird).**

**Great I.:** Cheeseman (1888 and 1891); Fraser (1929), "plentiful"; Oliver (1930); Johnson (1946); Falla (1948), subsp. nov. The bellbird is by far the commonest land bird and has been thus noted by Cheeseman and subsequent observers. We would estimate it as outnumbering every other species at present by at least ten to one. The male is of particularly distinctive plumage, with almost black mantle and white markings (Falla, ibid.). Nesting was over by November-December, 1945, but young birds not long out of the nest were quite common. Its diet must be predominatingly insectivorous, although *Metrosideros excelsa* Gaertn. (pohutukawa), and a few other nectar-bearing trees would provide a modicum of sweet substance. In May, 1946, in Tasman Valley, bellbirds were feeding from flowers of the rare bignoniaceous liane endemic to the group (Oliver, 1948). This plant was in abundant flower, and a dozen or more bellbirds were in the neighbourhood, singing in mellifluous chorus and fighting amongst the flowers hanging in rich creamy-green clusters (E.G.T.). In addition to the melodious song described by Falla (1948), both sexes have the same harsh call note, pitched a little higher in the female. **South West I.:** Cheeseman (1891) notes this species as abundant. Buddle (1948) records it as fairly plentiful in January, 1947; and makes the interesting observation that the plumage pattern is the same as on Great Island. **North East I.:** Six were seen by Buddle (ibid.) in January, 1947.

**Fringilla coelebs L. (chaffinch).**

**Great I.:** The chaffinch is present in small numbers, breeding on the island. An old nest was found in November-December, 1945, when on several occasions the full song was heard (P.C.B.).

**Carduelis cabaret (P. L. S. Mull.) (redpoll).**

**Great I.:** This species was observed in April-May, 1946, but only in flocks at some distance (E.G.T.).

**Carduelis carduelis (L.) (goldfinch).**

**Great I.:** The goldfinch was seen in April-May, 1946, only at some distance; the numbers present were small (E.G.T.).

**Passer domesticus (L.) (house sparrow).**

**Great I.:** A flock of c. 10 including males and females came close about the camp towards the end of the visit in April-May, 1946 (E.G.T.); approximately the same number were seen in 1945 (G.A.B.).

**Emberiza citrinella L. (yellowhammer).**

**Great I.:** Although seen a number of times in April-May, 1946, this species is not common; a flock of three observed closely were young birds or females (E.G.T.).

**Turdus ericetorum Turt. (song thrush).**

**Great I.:** Song was heard in the evenings in November-December, 1945; and a nest with four eggs was found (P.C.B.). A few thrushes were seen in April-May, 1946 (E.G.T.).

**Turdus merula L. (blackbird).**

**Great I.:** This species was recorded on 20th February, 1934. On subsequent visits it has been found to be fairly common, outnumbering all indigenous land birds except *Anthornis melanura*. The full song was heard throughout the day, except at noon, at the end of November and in early December, 1945; nests with eggs (one recorded contained four) were found on 1st and 5th December (P.C.B.). **South West I.:** Recorded as numerous by Buddle (1948), who found several nests containing young on 3rd January, 1947. Buddle refers to the possibility of competition for food on the forest floor between this species and *Porzana tabuensis,* following his earlier reference to a similar relationship between these two species on the Poor Knights (Buddle, 1941, 1946; Turbott, 1948). **North East I.:** Recorded by Buddle (1948).

**Prunella modularis (L.) (hedge sparrow).**

**Great I.:** Hedge sparrows were seen several times in April-May, 1946, in *Leptospermum* shrubland about the castaway depot and by other members of the party elsewhere; a couple in immature plumage were seen in tall *Leptospermum* on the eastern part of the island (E.G.T.). The invasion of the area north of Auckland by this species is comparatively recent, having occurred within the last fifteen years. Watt (1947) refers to it as having been present for approximately ten years in the farthest north.

**Sturnus vulgaris L. (starling).**

**Great I.:** The starling was observed by the "Will Watch" party in 1934 and has been recorded subsequently in fair numbers on all parts of the island, and particularly about the cliffs. Flocks of 20-30 were seen in 1946. **South West I.:** In January, 1947, Buddle (1948) saw several flocks. **North East I.:** Small flocks on the same date (Buddle, ibid.).

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## APPENDIX.

On 6th October, 1948, an Auckland Museum party, including the writers, landed for four hours on Great Island. We are grateful to Mr. A. J. Black, of the motor vessel "Alert," for providing this opportunity to examine the island.

The following land birds were recorded during this brief visit: *Synoicus* (brown quail), *Circus approximans* (harrier), *Cyanoramphus novaezelandiae* (red-fronted parakeet), *Rhipidura fuliginosa* (fantail), *Zosterops lateralis* (silvereye), *Carduelis carduelis* (goldfinch) and *Turdus merula* (blackbird). *Anthus novaeseelandiae* (pipit) was observed both in *Leptospermum ericoides* forest and on the grassland of Tasman Valley.

*Sterna striata* (white-fronted tern) was recorded, several calling as they passed over the island.

Burrows examined on the slopes above South East Bay proved to contain *Pelecanoides urinatrix* (diving petrel) and *Puffinus gavia* (fluttering shearwater) sitting on eggs; by 7.20 p.m. considerable numbers of diving petrels were circling close inshore above the landing.

The presence of *Zosterops lateralis* is of particular interest, several small flocks being recorded. These may have been stragglers, or may indicate a small population breeding on the island during the present season.

It would seem unlikely that the early stages in regeneration of the vegetation, to which reference is made by Baylis and by Turbott in this series, would yet have influenced the status of *Zosterops lateralis* or other land birds.

Through the courtesy of the Hon. Minister of Internal Affairs, a specimen of *Rhipidura fuliginosa* was collected during this visit. This skin, A.M. 17.30, from the neighbourhood of the castaway depot, has mutant plumage characters as in specimens which we have described; the tail feathers are much worn, and the under surface is probably correspondingly faded. Measurements: wing 70, tail 89, tarsus 18, toe 13, culmen 8 mm.

# A New Anthornis from Three Kings Islands.

By R. A. FALLA, Dominion Museum, Wellington, N.Z.

In listing the birds observed at the Three Kings Islands, Cheeseman (1888, p. 144), who does not include *Anthornis* in his first list, states: "Besides the species named above, another one is common which I failed to identify. It is about the size of the bell-bird, and has much of its appearance and habits, but the under-parts are greyish-white, and the song is altogether different. I regret that I was unable to obtain a specimen, for there is little doubt that it will prove to be an addition to our lists." However, on his second visit Cheeseman (1891, pp. 414-418) makes several references to having found bell-birds in great numbers on both South West and Great King, with no further query. A later recorder, Fraser (1929, p. 154), lists *Anthornis melanura* without critical comment, and describes the bird as plentiful.

In February, 1934, the Auckland Museum Expedition in the auxiliary ketch "Will Watch" also found bell-birds plentiful, but were impressed, as Cheeseman had been, with differences plain to the casual observer. A limiting collecting permit enabled specimens to be taken for the collections of the Auckland and Dominion Museums. An examination of these makes is clear that the Three Kings bell-bird is a distinctive form, differing from those of the main islands in consistent characters which are as well marked as, indeed in some respects more marked than, those that distinguish *Anthornis melanura melanocephala* of the Chatham Islands.

The following list of specimens used in this comparison gives some idea of size differences, and it may be remarked that only slight plumage differences, which have not been fully analysed, can be used to separate the bell-bird populations inhabiting North Island, South Island, Stewart Island, and all the outliers. Even the Auckland Island subspecies is distinguished by very slight and secondary colour tone differences in the metallic feathering.

**Anthornis melanura obscura** n. subsp.

**Adult Male:** Generally similar to *A. melanura melanura* but differing in that it is slightly larger, the bills of males averaging 3 mm. longer, and of females 2 mm. The body plumage is dull olive green, with no trace of the yellowish olive found on the underparts of the typical form; forehead, crown, sides of head, and throat are glossed with dull violet instead of bright purple; quills and tail deeper black with much less olive on the margins of the outer webs of the secondaries, patches of feathers on the sides of the breast and the crissum and under tail coverts white tinged with cream. Iris dull red. Feet lead grey. Bill black.

**Adult Female:** Similar to *A. melanura melanura* but larger and with plumage generally more greenish grey and much less olive brown.

**Young:** Not collected.

*Type:* Auckland Museum No. 15.22, ♂, Three Kings Is., February, 1934.

The Three Kings bell-bird is readily distinguishable in the field. Its larger size is apparent if the observer has recently seen the bell-bird of the mainland or islands further south. Against the dull green plumage and black wings and tail, the white pectoral plumes and under-tail coverts offer a more striking colour contrast than do the yellow counterparts of *A. melanura melanura* against its bright olive green. Both sexes of the Three Kings birds have melodious songs, differing from the songs heard elsewhere, but this is characteristic of all isolated groups of *Anthornis*.

| | No. | Sex. | Locality | Wing | Tail | Tar. | Toe | Cul. |
|---|---|---|---|---|---|---|---|---|
| Anthornis n. subsp. | A.M. 15.22 | ♂ | Three Kings | 93 | 86 | 27 | 24 | 17 |
| | 15.23 | ♂ | Three Kings | 93 | 83 | 27.5 | 22 | 17.5 |
| | 15.24 | ♀ | Three Kings | 82 | 71 | 25 | 23 | 15 |
| Anthornis m. melanura | 15.19 | ♂ | Chickens | 90 | 86 | 26 | 22 | 14 |
| | 15.10 | ♂ | Motuihi | 92 | 83 | 23 | 22 | 14 |
| | 15.9 | ♂ | Motuihi | 90 | 84 | 23 | 21 | 14 |
| | 15.7 | ♂ | Cuvier | 92 | 87 | 23 | 20 | 14.5 |
| | 15.8 | ♂ | Little Barrier | 90 | 85 | 26 | 21 | 14 |
| | 15.20 | ♂ | Poor Knights | 88 | 79 | 27 | 20 | 15.5 |
| | 15.14 | ♂ | Otago | 91 | 82 | 27 | 21 | 14.5 |
| | 15.15 | ♂ | Otago | 90 | 84 | 25 | 22 | 14.5 |
| | 15.12 | ♀ | Otago | 80 | 70 | 25 | 20 | 13 |
| | 15.13 | ♀ | Otago | 84 | 74 | 25 | 21 | 13.5 |
| | C.M. 1093.6 | ♂ | Kaituna | 92 | 87 | 26 | 22 | 15 |
| | 1093.7a. | ♂ | Akaroa | 90 | 78 | 25 | 21 | 15 |
| | 1093.7b. | ♀ | Akaroa | 85 | 73 | 24 | 20 | 14.5 |
| Anthornis incoronata | 1093.19 | ♂ | Auckland Is. | 91 | 85 | 25 | 22 | 14.5 |
| | 1093.20 | ♂ | Auckland Is. | 93 | 86 | 25 | 25 | 14.5 |

NOTE.— A.M. = Auckland Museum. C.M. = Canterbury Museum.

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# A Note on the Occurrence of the Genus Hoplodactylus Fitzinger in New Zealand.

By N. G. STEPHENSON, M.Sc., Auckland University College.

The genus *Hoplodactylus* Fitzinger, Syst. Rept., 1843, pp. 19 and 100 (type *Platydactylus duvaucelii*), is one of the two genera of geckos endemic to New Zealand. G. A. Boulenger (Cat. Brit. Mus., Vol. I, p. 171, 1885) accords it a comparatively wide range through South Pacific islands and Southern India. It has also been listed by Lucas and Frost in the "Animals of Australia," and the old collections of the British Museum and Paris contain specimens of *H. pacificus* from Tasmania and the Marquesas Islands. There is now no doubt that these localities are erroneous. Careful investigation has made it quite clear that the genus does not occur in Australia and there has been no further record of its occurrence in the Pacific Islands.

Boulenger (1885) recognised five species, namely, *Hoplodactylus maculatus, H. pacificus* and *H. granulatus* from New Zealand, *H. duvaucelii* from Bengal and *H. annamallensis* from Southern India.

For many years the view has been held in New Zealand that *H. duvaucelii,* described by Boulenger as having come from Bengal, was really a New Zealand form. This view was substantiated by the fact that there was in New Zealand one or more spirit specimens, of doubtful origin, which conformed with the descriptions of *H. duvaucelii.* It was not, however, until January, 1939, that any direct proof of the occurrence of *Hoplodactylus duvaucelii,* in a definite New Zealand locality, was obtained. During this month two specimens were collected from one of the Hen and Chickens Islands, off the east coast, north of Auckland. Both these specimens were sent directly to the British Museum for examination and classification and at least one specimen is known to have survived the journey. In November, 1939, a third specimen was collected from the same island. In February, 1940, a specimen of *H. duvaucelii* was collected from the Chickens Islands by Mr. C. A. Fleming while in November of the same year *H. duvaucelii* was collected from Aorangi, Poor Knights Islands.

It was pointed out by Malcolm A. Smith (Records of the Indian Museum, Vol. XXXV, 1933, p. 9-19) that *H. duvaucelii* had never since been found in any part of India. Smith compared specimens of *H. pacificus* with the types and only known specimens of *H. duvaucelii* and observed that except for a difference in size (the snout to vent measurements being 70 mm. in the former and 120 mm. in the latter, for the largest specimens in the British Museum) and the number of sub-digital lamellae, the two were identical. He concluded that *H. duvaucelii* "was very closely allied to, if not a race of, one of the New Zealand forms,"

and suggested that some error must have occurred in the labelling of the original specimens, a reasonable supposition in view of the fact that there is nothing in common between the faunas of New Zealand and India. Smith was able to confirm his view concerning the occurrence of *H. duvaucelii* when, a little later, a living specimen of *H. duvaucelii*, captured on one of the islands of the Hen and Chickens group, off the east coast of the North Island of New Zealand, arrived in London. (Records, Indian Museum, Vol. XXXV, p. 13.)

## SYNOPSIS OF NEW ZEALAND SPECIES (Malcolm Smith).

A. 10 to 14 lamellae (the posterior usually divided) beneath the free terminal phalanges of the outer four digits.

10 to 12 curved lamellae beneath the dilated portion of the digit ........ *H. pacificus.*

16 to 18 curved lamellae beneath the dilated portion of the digit ........ *H. duvaucelii.*

Lamellae beneath the dilated portion of the digit straight, transverse ........ *H. granulatus.*

B. 4 to 6 lamellae beneath the terminal phalanges of the outer four digits, which are not more than half the length of the dilated portion.

Lamellae beneath the dilated portion of the digit curved ........ *H. maculatus.*

*H. annamallensis*, according to Smith, can be distinguished from the true *Hoplodactylus* (now to be defined as a genus of geckos endemic to New Zealand) "by several small but distinct characters and should be placed in a separate genus." He proposes *Dravidogecko*, gen. nov., monotype *Gecko annamallensis* Günther, and says, "the similarity which the two genera bear one another in external characters is due, no doubt, to parallel evolution and not to phylogenetic relationship." Smith further states that the following characters serve the two:

Free terminal phalanges rising from the end of the expanded portion of the digit; inner digit with a minute claw, or the claw concealed; male pores in multiple series ........ *Hoplodactylus.*

Free terminal phalanges rising from within the expanded portion of the digit; inner digit with distinct claw; male pores in single series *Dravidogecko.*

Specimens of *Hoplodactylus* collected in April and May, 1946, by a Museum collecting party from Auckland which visited the Three Kings Islands have added fresh evidence on the systematic position of *H. duvaucelii*. Four specimens, collected from the Great Island, Three Kings, have shown that size and lamellar number do not sharply define

*H. pacificus* and *H. duvaucelii* from one another and that both types may possibly occur on one island. The evidence now available confirms the possibility, suggested by Malcolm Smith, that *H. duvaucelii,* as a species, is not distinct from *H. pacificus.*

SPECIMEN A (Great Island, Three Kings, 1946)

| | |
|---|---|
| Snout to vent .. .. .. .. .. .. | = 85 mm. |
| Number of lamellae beneath the dilated portion of fourth toe (posterior usually divided) .. .. | = 15 |

SPECIMEN B (Great Island, Three Kings, 1946).

| | |
|---|---|
| Snout to vent .. .. .. .. .. .. | = 75 mm. |
| Number of lamellae beneath the dilated portion of fourth toe (posterior usually divided) .. .. | = 16 (left)<br>= 15 (right) |

SPECIMEN C (young specimen) (Great Island, Three Kings, 1946).

| | |
|---|---|
| Snout to vent .. .. .. .. .. .. | = 39 mm. |
| Number of lamellae beneath the dilated portion of fourth toe (posterior usually divided) .. .. | = 16 |

SPECIMEN D (Great Island, Three Kings, 1946).

| | |
|---|---|
| Snout to vent .. .. .. .. .. .. | = 89 mm. |
| Number of lamellae beneath the dilated portion of fourth toe (posterior usually divided) .. .. | = 15 |

SPECIMEN E (young specimen) (Great Island, Three Kings, 1946).

| | |
|---|---|
| Snout to vent .. .. .. .. .. .. | = 38 mm. |
| Number of lamellae beneath the dilated portion of fourth toe (posterior usually divided) .. .. | = 14 (left)<br>= 15 (right) |

It is evident from the measurements of the above four specimens that the key to the New Zealand species, suggested by Smith as a replacement for the original key of Boulenger, also breaks down as far as *H. pacificus* and *H. duvaucelii* are concerned. In conclusion, one might state that further field observations and measurements of the geckos on islands north of Auckland could be expected to provide a series of intermediate forms and furnish some of the data which will be required before a more complete revision of the New Zealand species of *Hoplodactylus* can be attempted.

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Photograph of *Hoplodactylus* (*duvaucelii* type), showing 17 lamellae beneath the dilated portion of the fourth toe, the anterior chevron-shaped, the posterior divided, and smaller lamellae beneath the free terminal portion of the digits.

*Photo. L. H. Millener, University College, Auckland.*

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# CONTENTS

## VOL. 3, NO. 6.

# The Occurrence of Australian Echinoids in New Zealand Waters

By H. BARRACLOUGH FELL,

Victoria University College, Wellington.

## Abstract.

*Clypeaster australasiae* is recorded for the first time from New Zealand. The species *Holopneustes inflatus* and *Centrostephanus rodgersii*, though reported from New Zealand over fifty years ago, were subsequently deleted from the faunal list for lack of reliable evidence. Accurate localities are now given for specimens taken alive, and also for other material in unmacerated condition, with adherent spines and pedicellariae. The new evidence invalidates the theory recently proposed by H. L. Clark (1946) that New Zealand records of *Holopneustes inflatus* are attributable to dead material of Australian origin which has drifted across the Tasman Sea on floating kelp. All three species must be recognized as true members of the New Zealand fauna. Since two of them are also known from Lord Howe Island, their geographical range probably corresponds to the shallow water boundaries of the Tasman basin on its western, northern and eastern margins.

## REGULARIA

### Family DIADEMATIDAE

### Genus CENTROSTEPHANUS Peters, 1855.

**Centrostephanus rodgersii (A. Agassiz)**

1863. A. Agassiz, *Proc. Acad. Nat. Sci. Philadelphia, 1863*, p. 354.

*Localities:* Off Cavalli Islands, south of Whangaroa, in from 70 to 110 metres, two large specimens collected alive in July, 1949; also from Stephenson's Island, Whangaroa, several specimens collected about the year 1925 by the late W. La Roche, though apparently not hitherto placed on record. A specimen from each of these localities is in the Auckland Museum.

The dimensions of the Stephenson's Island example are as follows: Horizontal diameter of test, 97 mm.; height of test, 48 mm.; peristome, 38 mm.; apical system, 21 mm.; longest spines, 45 mm.; number of plates to each column, A 28, IA 16. The largest specimen listed by Mortensen (1940) measures h.d. 95 mm., height 45 mm. However, the late H. L. Clark (1946) has recorded that Australian specimens reach 100 mm. h.d., or more.

The test is pale cream; the spines have the deep purple coloration characteristic of the species. The spines and skin of one of the Cavalli Island specimens are very strongly pigmented, approaching black.

*C. rodgersii* was first reported from New Zealand by Farquhar (1897) on the basis of a specimen in the then Colonial Museum; he was unable to cite the locality from which it was obtained, and stated that the specimen fell to pieces on its removal from its case. Hutton (1904) omitted the species from the *Index Faunae Novae Zealandiae*, but

Farquhar (1907) corrected this error. Mortensen (1921) again dropped the species from his revised list of New Zealand echinoids, and subsequently (1940) maintained this view. As the evidence for its New Zealand occurrence is now conclusive, the species must be restored to the faunal list. The geographical range of *C. rodgersii* as known so far comprises eastern Australia, Lord Howe Island and New Zealand.*

## Family TEMNOPLEURIDAE

### Genus HOLOPNEUSTES L. Agassiz, 1841.

#### Holopneustes inflatus Lütken

1872. Lütken, in A. Agassiz, *Bull. Mus. Comp. Zool.*, 3, 56.

This echinoid has recently been obtained in some numbers from the North Auckland peninsula, and as far south as Great Barrier Island. It is represented in a number of New Zealand collections. Auckland Museum possesses the finest specimen I have seen; it was taken at Houhora Heads in August, 1934, the depth not being recorded. It is of the *purpurescens* form (vide Mortensen, 1943), in perfect condition, and obviously alive when collected. It measures ca. 60 mm. h.d., and 40 mm. in height. The densely arranged spines measure individually up to 5 mm. in length, and are of a delicate, translucent mauve colour, paler at the distal extremity of each. The spines about the peristome are somewhat flattened, a feature which does not seem to have been reported in Australian specimens. Owing to the shortness of the spines, the tube-feet show up prominently as ten narrow, meridional bands, buff in colour, harmonising well with the mauve spines. This, indeed, must be one of the most beautiful sea-urchins of our fauna. The characters of the ambulacral plates, including the trigeminal arrangement of the pore-pairs, the occlusion of the lower element from the outer border of each amb-plate, and the tuberculation of the inter-amb plates, all correspond with published descriptions of Australian material.

Another large, but almost naked, test of 50 mm. h.d. was collected by A. W. B. Powell at Tryphena, Great Barrier Island, in ca. 30 metres. This carries a few spines and pedicellariae. Some 16 specimens, several with abundant spines and pedicellariae, were collected by Gladys Mumby from sandy beach at Doubtless Bay; these are in the Dominion Museum, and others from the same collector are in the museum of the Correspondence School, Wellington, and in the writer's collection.

*H. inflatus* was first recorded from New Zealand by A. Agassiz (1872), though omitted from the *Index* by Hutton (1904). This is surprising, since Hutton himself obtained a specimen (which he originally described as "*Echinus elevatus*" in 1872)—this specimen being still preserved in the Dominion Museum. Mortensen (1921) restored the species to the faunal list on the basis of a naked test taken by Bollons at Little Barrier Island, but subsequently (1943) he has treated the

* Since the above was written Mr. A. W. B. Powell obtained a living specimen from a trawl on the edge of the Centre Reef, Hauraki Gulf; 5½ miles S.E. of Little Barrier Island, 25-28 fathoms.

matter as uncertain. H. L. Clark (1946) regarded the occurrence of bare tests as providing no evidence of the species' occurrence, as he thought dead tests might be transported long distances on floating kelp. He concluded: "It is quite improbable that either *Amblypneustes* or *Holopneustes* lives in New Zealand seas."

The character of the material recorded above can leave no further grounds for maintaining such an opinion. The species is therefore to be retained on the faunal list. Its known geographical ranges comprise south and eastern Australia, Tasmania and New Zealand.

It is worthy of note that Farquhar (1926) recorded *Amblypneustes pachistus* (under the name *A. ovum* var. *pachistus*) from New Zealand. Since he is now proved correct in the cases of *C. rodgersii* and *H. inflatus*, there is strong reason to accept his report of *A. pachistus*.

## IRREGULARIA

### Family CLYPEASTRIDAE

### Genus CLYPEASTER Lamarck, 1801.

**Clypeaster australasiae (Gray)**

1851. Gray, *Proc. Zool. Soc., 1851*, p. 34.

Specimens recently dredged by A. W. B. Powell from 157 metres, off East Cape, and also off Parengarenga in from 70 to 90 metres, are all referable to this species. They are located in the Auckland Museum.

Australian specimens show considerable variation in the shape of the test, as discussed by Mortensen (1948), and a corresponding variation is apparent from the dimensions of the three New Zealand examples submitted to me.

| Specimen. | Length. | Breadth. | Height. | Length of Spines. Aboral. | Length of Spines. Adoral. |
|---|---|---|---|---|---|
| A | 116 mm. | 104 mm. | 32 mm. | 3 mm. | 1-2 mm. |
| B | 99 mm. | 90 mm. | 32 mm. | 3.5 mm. | 1-2 mm. |
| C | 92 mm. | 84 mm. | 23 mm. | 3 mm. | 1-2 mm. |

*Note.*—Specimen C has a depressed apical region.

This is the second species of *Clypeaster* to be reported from New Zealand, and the first for which an accurate locality and depth is available. The other is *C. virescens* Doderlein, of which H. L. Clark (1925) recorded two specimens in the British Museum labelled "from off New Zealand (Terra Nova)." Bell (1917), in the official report on the *Terra Nova* echinoderms, had included no reference to such specimens.

## KEY FEATURES.

To facilitate the recognition of any other specimens of these echinoids which may be obtained locally, the following characters may serve to distinguish them from other New Zealand species.

**Centrostephanus rodgersii** is at once recognizable by its large, robust test, its long, tapering, hollow spines, and deep purple colour.

**Holopneustes inflatus** is characterized by its almost spherical test, rarely exceeding 50 mm. in diameter, and by its dense coating of numerous short, red, bristle-like spines. In the case of the form purpurescens, the test may be larger, up to 70 mm. or so diameter, and the spines are mauve or purple. The large forms are more nearly hemispherical than the smaller ones.

The two species of **Clypeaster** are superficially similar; both are flattened shield-urchins, of oval or sub-pentagonal outline, with the aboral surface raised sub-conically, and bearing five petaloid ambulacra with the pore-series distally unclosed. **C. australasiae** has a concave lower surface, and 6-9 tubercles occur on each transverse costa between pore-pairs, the tubercles of the more distal costae being arranged in double series, while those of the remainder are in single series. **C. virescens** has a more nearly flat adoral surface, and not more than four tubercles occur on each costa, always in single series.

## ACKNOWLEDGMENTS.

I have to thank Mr. A. W. B. Powell, Assistant Director of the Auckland Museum, for the opportunity to examine and report upon the material. Mr. R. Sharell, of the Correspondence School, Wellington, has also been responsible for assembling material of *H. inflatus*, and his co-operation is gratefully acknowledged.

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# The Paryphantidae of New Zealand

## No. VI. Distribution, hybrids and new species of Paryphanta, Rhytida and Schizoglossa.

By A. W. B. POWELL, Assistant Director.

ABSTRACT.

A distributional survey, with map, of the *Paryphanta lignaria* group of subspecies, from Buller County, West Coast, New Zealand. Hybrid colonies resultant from river floods, attributable in two instances, to the Mokihinui River flood following the 1929 Murchison Earthquake. Evidence on speciation in support of Mayr's views on hybrid populations. New species and subspecies of *Paryphanta* (4), *Rhytida* (2), and *Schizoglossa* (2).

### Genus PARYPHANTA Albers, 1850.

### Subgenus POWELLIPHANTA O'Connor, 1945.

### 1. THE LIGNARIA SERIES.

In 1946 (Rec. Auck. Inst. Mus. 3 (2), p. 106) I recorded the difficulties encountered in the exact interpretation of Hutton's *lignaria*. The chief points are as follows:—

(1) The holotype is not in the Canterbury Museum as stated by Suter (Man. N.Z. Moll. p. 783), but was returned to its discoverer, Dr. Gaze, of Westport (Suter l.c. errata, p. XIV).

(2) The type locality was given as "the saddle between the Mokihinui and Lyell Rivers."

(3) The type specimen was described as "irregularly banded in the direction of the growth lines with dark reddish-brown and pale brownish-yellow"—"upper surface finely irregularly granulated by deeply undulating impressed lines." "The lower surface is broken off, so as to leave the shape of the umbilicus and the aperture uncertain." "Greatest diameter about 2 inches and least diameter 1½ inch."

(4) In 1900 Hutton figured an example without colour bands, said to come from Mt. Rochefort, near Westport, and erroneously ascribed it to his original *lignaria*. This specimen is evidently my *unicolorata* (see next reference) and came from Seddonville. Mt. Rochefort specimens recently obtained by both Dr. W. R. B. Oliver and Mr. W. H. Johnston are a new subspecies of *rossiana*, described following.

(5) In 1930 (Rec. Auck. Inst. Mus. 1 (1), p. 42, Pl. 4, f. 1) I identified shells from St. Helens, Mokihinui, as Hutton's original *lignaria*.

(6) In 1941 (l.c. 2 (5), p. 239) I nominated a St. Helens, Mokihinui, specimen as neotype of *lignaria*, since the holotype was presumed to have been lost.

(7) In 1946 (l.c. 3 (2), p. 106) I recorded the finding of an unlabelled specimen from the collection of the late Mr. Boswell, of Westport, which may be Dr. Gaze's specimen, holotype of Hutton's original *lignaria*. This specimen tallies with Hutton's description except for the dimensions, which are slightly greater than those given by Hutton—viz. $2\frac{1}{8}$ inches x $1\frac{3}{4}$ inches. However, since the base is missing, the body-whorl has undoubtedly sprung or spread, and this would account for the present slightly greater dimensions. Also, it should be noted that Hutton qualified his dimensions, with "about." If this specimen is Hutton's type, then my 1930 and 1946 interpretation of *lignaria* is correct, but the locality cited by Hutton is not.

(8) No specimens from Hutton's alleged type locality have since been found.

(9) In 1946 (l.c. 3 (2), p. 106) I recorded a specimen from the collection of Mr. Arthur Richardson, of Papakura, said to have come from Larrakin's Creek, a tributary of the South Branch of the Mokihinui River and draining the high watershed between the Mokihinui and Matiri Rivers, which is near to Hutton's alleged type locality. However, Mr. W. H. Johnston, of Seddonville, reports that local deer stalkers have been unable to find any snails in the Larrakin's Creek area; and, further, that Mr. E. De Malmanche, from whom Mr. Richardson got the specimen, actually found it at river level about a mile up the South Branch of the Mokihinui. Since the numerous subspecies of "*lignaria*" occupy relatively small areas, the Richardson specimen cannot be considered topotypic of *lignaria*. Reconsideration shows it to be a *unicolorata* x *ruforadiata* hybrid.

(10) Several deer stalkers have since traversed the high tops in the vicinity of the "Mokihinui-Lyell" Saddle, but failed to find any large snails. If *Paryphanta* snails do materialise from this area a form of *rossiana* is to be expected, and any such would scarcely fit Hutton's description of *lignaria*.

(11) My conclusion now is that Hutton's *lignaria* definitely applies to the St. Helens shells and that the locality originally cited is incorrect.

The specimen selected for the neotype, however, was an empty shell and has been stained slightly, and appears more reddish-brown than in fresh material.

This last point is important, since there are two distinct colour forms of *lignaria*.

In a paper "The Species Problem in New Zealand Land Snails" read at the New Zealand Science Congress, Wellington, 1947 (Powell, 1949, Trans. Roy. Soc. N.Z. 77 (5))* I described at some length the distribution of the *lignaria* group of snails and the probable genetical and other factors involved, which are summarised as follows:—

(1) Over 400 square miles of more or less continuous forest, between the Mokihinui and Little Wanganui Rivers, is occupied by two colour forms of *lignaria*, one (typical) from the southern drainage has

* Not published at time of going to press.

a yellowish or greenish-yellow ground colour, while the other from the northern drainage has a reddish-brown ground colour.

(2) The two colour forms of *lignaria* cannot be accounted for under clinal variation, since no intermediates were found. Each colony so far located has been either one colour or the other, and strictly in relation to the other colonies of the side of the range it occupies.

(3) Probable polymorphic nature of the species is suggested. It may be that the yellowish ground colour of the snails from the Mokihinui side is due to infiltration over a long period by the khaki coloured *unicolorata* from the south side of the river, and by the same criterion the reddish-brown ground colour of those from the northern drainage may be due to former contact or infiltration from a reddish stock now represented by *annectens* from north of the Karamea River.

(4) That infiltration does occur is definitely shown by hybrid colonies at Sawyer's Creek, a tributary of the Mokihinui River, at St. Helens, and also at Summerlea on the opposite or southern side of the river near the mouth (see note on these hybrid populations, p. 354).

(5) Since *lignaria* and *unicolorata* freely hybridise when chance mixing occurs, they are better evaluated as subspecies than species.

## 1a. The lignaria group of subspecies.

### LOCALITY KEY.

Leslie and Upper Karamea Rivers .......................... *lignaria oconnori*

Little Wanganui to Corbyvale ................................ *lignaria lusca*

Kongahu Point—Carlins Flat to Mokihinui River ............. *lignaria lignaria*

Seddonville Flat and river flats of Mokihinui South Branch .. *lignaria unicolorata*

North branch and north bank, Mokihinui Gorge ............. *lignaria ruforadiata*

Western drainage, Glasgow Range ........................... *lignaria rotella*

Coast range, bounded by sea, Mokihinui and Ngakawau Rivers,
Chasm and Charming Creeks ......................... *lignaria johnstoni*

### COLOUR PATTERN KEY.

(A) Conspicuous radial streaks.

a. Numerous radials.

1. On a yellowish ground colour ...................... *lignaria lignaria*
2. On a reddish-brown ground colour ................... *lignaria lusca*

b. Wide spaced radials.

3. On an orange-brown ground colour ................ *lignaria oconnori*

(B) Inconspicuous broad reddish-brown streaks.

4. On brown to raw-umber ground ................. *lignaria ruforadiata*

(C) Sparse narrow radial dark lines.

5. Ground colour reddish-brown spirally lined above, khaki below ........ ................................................ *lignaria rotella*

(D) Conspicuous spiral reddish-brown lines and zones, above and below ........ ................................................ *lignaria johnstoni*

(E) Plain khaki, above and below ........................ *lignaria unicolorata*

**Paryphanta lignaria lignaria** Hutton, 1888.

1888. *Paryphanta lignaria* Hutton, Trans. N.Z. Inst. 20, p. 43.

1913. *Paryphanta lignaria:* Suter (in part), Man. N.Z. Moll., p. 783.

1930. *Paryphanta lignaria:* Powell, Rec. Auck. Inst. Mus. 1 (1), p. 42, Pl. 4, f. 1.

1941. *Paryphanta lignaria:* Powell, Rec. Auck. Inst. Mus. 2 (5), p. 239 (Neotype).

The typical subspecies has a yellowish ground colour (olive lake, Ridgway, 1912, pl. 16) on the base, and russet (Ridgway, pl. 15*) on the dorsal surface. The colour division occurs sharply, just above the periphery, and coincides with the outer extremity of the spiral sculpture. The whole shell is axially striped and banded with dark reddish-brown to almost black. There is a general tendency towards narrow stripes with much of the ground colour showing.

*Localities:* "Saddle between Mokihinui and Lyell Rivers, Nelson" (Type locality, but evidently incorrect); About 1½ miles up Marris' Tramway, near junction of Mumm and Stillwater Creeks, St. Helens, Mokihinui, 120 feet (Neotype, Powell, 1941, Rec. Auck. Inst. Mus. 2 (5), p. 239); Between Sawyer's and Stillwater Creeks, St. Helens, Mokihinui, 80-100 feet (A.W.B.P. and A. C. O'Connor, 1947); Hill-top, 899 feet, west of Sawyer's Creek (A.W.B.P. and A. C. O'Connor, 1947); Old Man Rock, 300 feet, Kongahu Point, six miles north of Mokihinui River (A. Richardson); First watercourse Mokihinui-Karamea Road; The Bluff or View Hill Saddle, 1376 feet, Mokihinui-Karamea Road (A.W.B.P., 1947, and A. C. O'Connor, March, 1949); Carlin's Flat, head of Six Mile Creek, 660 feet, Mokihinui-Karamea Road (A.W.B.P. and R. A. Prouse, 1948).

Major diameter, 47.0 mm.; min. diam., 39.0 mm; height, 26.0 mm. (Neotype)

Major diameter, 56.5 mm.; min. diam., 47.0 mm.; height, 32.0 mm. (St. Helens)

Major diameter, 65.0 mm.; min. diam., 57.0 mm.; height, 38.5 mm. (St. Helens)
*Neotype:* Powell Collection, Auckland.

**Paryphanta lignaria lusca** n. subsp. Pl. 66, fig. 2.

This subspecies has a uniformly reddish-brown ground colour, not bi-zoned as in the typical species. The ground colour varies through Buckthorn brown, russet and Mars brown (Ridgway, 1912, pl. 15). There is a general tendency towards wide axial bands with little of the ground colour showing.

The shell is more solid and the spire more elevated than in the typical subspecies.

*Localities:* Glass-Eye Creek, Mokihinui-Karamea Road (A.W.B.P. and A. C. O'Connor, 1947); lower slope of small hill west side of Mokihinui-Karamea Road at Corbyvale (A.W.B.P. and R. A. Prouse, 1948); hill on south side of Lower Glass-Eye Creek, ca. 900 feet, Little Wanganui (A.W.B.P. and A. C. O'Connor, 1947).

On the Mokihinui Road the division between *lignaria lignaria* and *lignaria lusca* occurs over the short distance of one mile between Carlin's and Corbyvale, but on the coast the division has not as yet been recorded. A transverse ridge runs between Carlin's and Corbyvale and terminates on the coast at Kongahu Point. The snails, however, seem to be distributed in relation to stream valleys rather than to the ridges, the latter being for the most part steep with little humus and consequently very few earthworms (worms form the staple diet of these snails).

* Ridgway, R., 1912. Color Standards and Color Nomenclature. Washington, U.S.A.

The streams associated with the typical subspecies are Sawyer's, Stillwater, Mumm, Tobin, Three Mile, Sandel and Six Mile Creeks. Their drainage is mainly west and south. The subspecies *lusca* is associated with Glass-Eye and Fall Creeks, both of which have a north-west drainage.

Major diameter, 55.5 mm.; min. diam., 46.0 mm.; height, 33.0 mm. (holotype)

Major diameter, 57.5 mm.; min. diam., 48.0 mm.; height, 35.0 mm. (paratype)
*Holotype:* Auckland Museum.

## Paryphanta lignaria oconnori Powell, 1938.

1938. *Paryphanta lignaria oconnori* Powell, Rec. Auck. Inst. Mus. 2 (3), p. 134, Pl. 33, figs. 3-6.

This subspecies is evidently confined to the upper drainage of the Karamea and Leslie Rivers, but does not descend to the coastal stretch between the Little Wanganui and Karamea Rivers. I have scarched much of the low forested hills around the Whangapeka Valley without success, although local farmers reported having seen large snails carried down over the flats by floods.

*Localities:* Headwaters of the Leslie River, tributary of the Karamea River, 2,000 feet; between Gordon's Pyramid, 4,900 feet, and Mt. Arthur, 5,834 feet, western slopes of Mt. Arthur Tableland (type). Two miles south of the Karamea River and eleven miles E.N.E. of Karamea township, 500-1,500 feet. A large colony in mixed forest, covering an area of at least one square mile and extending indifferently over Altonian mudstone, limestone and granite (H. W. Wellman, 1948).

### 1b. The unicolorata group of subspecies.

In general terms the Mokihinui River forms a barrier between the *lignaria* and *unicolorata* populations, the former to the north and the latter to the south of the river.

I have already shown that contrary to expectation *Paryphanta* snails will survive floods, even prolonged submergence, and that during these floods living snails may be transported. This is effectively demonstrated by the occurrence of at least two hybrid colonies (*lignaria* x *unicolorata*), one at Sawyer's Creek, St. Helens, on the north side of the Mokihinui River and the other at Summerlea on the south side of the river near the mouth.

In April, 1948, I found a living example of *unicolorata* under driftwood at Sawyer's Creek bend, where it had obviously come to rest after a flood, which occurred during the previous week.

The great flood following the 1929 Murchison Earthquake must have transported large numbers of snails, many of which no doubt escaped destruction by being carried inshore at bends. It is likely that the large colony of hybrids at Summerlea owes its origin to this 1929 flood.

Mr. W. H. Johnston's valuable field work, coupled with that of Mr. H. Wellman and my own investigations in collaboration with Mr. A. C. O'Connor and Messrs. R. A. and H. S. Prouse, have resulted in fairly comprehensive mapping of the distributional areas occupied by the several subspecies. Although many of the colonies show hybrid influences, at least four geographic subspecies are recognisable.

(1) *unicolorata.* Plain khaki coloured, top and base. Western side of the South Branch of the Mokihinui River and down through the south side of the gorge to the Seddonville Flat (type locality).

(2) *ruforadiata.* Brown to raw umber with broad sparse dark reddish-brown radial streaks. Maori Gully and North Branch (type locality) of the Mokihinui River and down the north side of the gorge. Hybridising with *unicolorata* on the south side through the gorge and near the railway tunnel below Seddonville.

(3) *rotella.* Top reddish-brown, base khaki. Spiral colour lines on top and base with sparse radial narrow dark bands. Western drainage of Glasgow Range, including Hydro (State) Mine Ridge, above Seddonville. As a slight hybrid influence in *unicolorata* colonies at Seddonville.

(4) *johnstoni.* Spiral colour lines and zones, top and base. In forest and on high-level silver pine "pakihis." Isolated block bounded by Mokihinui River to the north, Ngakawau River to the south, the sea to the west, and two deeply cut streams to the east, Chasm Creek and Charming Creek. Slight infiltration between *johnstoni* and *rotella* where the upper reaches of the two streams are less effective as barriers.

**Paryphanta lignaria unicolorata** Powell, 1930.

1900. *Paryphanta lignaria* Hutton (not of Hutton, 1888), Trans. N.Z. Inst. 32, p. 22, Pl. 2.

1930. *Paryphanta unicolorata* Powell, Rec. Auck. Inst. Mus. 1 (1), 43, Pl. 4, f. 2, and Pl. 6, f. 6.

1946. *Paryphanta unicolorata:* Powell, Rec. Auck. Inst. Mus. 3 (2), p. 107.

*Localities:* Seddonville, West Coast (type), from around flax (Phormium) (C. L. Wragge); "Mt. Rochefort," Hutton's locality for his 1900 record of "*lignaria*" is evidently erroneous, the specimen being a *unicolorata* probably from the Seddonville area; Seddonville flat, under blackberry bushes, willows, and decaying logs from between railway station and Mokihinui River. The area was formerly in heavy lowland rainforest. Includes about 5% with "*rotella*" influences, i.e., light-brown spiral lines on the dorsal surface and irregularly disposed dark-brown axial streaks (A. C. O'Connor and A.W.B.P., 1947); Pigeon Island and small island adjoining it, Mokihinui River above Seddonville, map S. 25, ref. ca. 455975 (W. H. Johnston, 1946) (slight *ruforadiata* influence); Between Chasm Creek and Page's Creek, above road, ¾ mile N.W. of Seddonville (W. H. Johnston and A.W.B.P., Jan., 1947) (strong *ruforadiata* and moderate *rotella* influences); Between Chasm Creek and Page's Creek, below road and railway to river bank (W. H. Johnston and A.W.B.P., Jan., 1947) (moderate *ruforadiata* influence); Between railway tunnel, Chasm Creek and Mokihinui River (W. H. Johnston and A.W.B.P., Jan., 1947) (strong *rotella* influence); 1 mile east of Seddonville, river terrace, old Karamea Road (W. H. Johnston and A.W.B.P., Jan., 1947) (strong *ruforadiata* influence); Lake Perrine (formed by 1929 earthquake), south side below junction of North and South branches of Mokihinui River; Limestone Creek, west side of South Branch, Mokihinui River, map S. 25, ref. ca. 628948 (F. Hughes); Owen Creek, west side of South Branch, Mokihinui River, map S. 25, ref. ca. 614887 (F. Hughes); Junction of Specimen Creek and Mokihinui River, map S, 25, ref. 592977 H. Wellman, 1948) (moderate *ruforadiata* influence); Welcome Creek, south side of Mokihinui River Gorge, map S. 25, ref. ca. 488967 (W. H. Johnston and A.W.B.P., April, 1948) (moderate *ruforadiata* influence); Coal Creek, south side of Mokihinui River, 1 miles E. of Seddonville, map S. 25, ref. ca. 458964 (W. H. Johnston, March, 1947) (strong *ruforadiata* influence); Johnny Cake Creek to within ½ mile of Andersen Creek, Mokihinui Gorge, south side, 80 feet above river, map S. 25, ref. ca. 505982 (W. H. Johnston, 20/3/1947) (strong *ruforadiata* influence); Welcome Creek to Johnny Cake Creek, Mokihinui Gorge, up to 300 feet above river, map S. 25, ref. ca. 493970 (W. H. Johnston, 20/3/1947).

The subspecies *unicolorata* belongs for the most part to the river flats of the South Branch and the southern side of the Mokihinui River. Owing to the mixing or infiltration caused by flooding, most of the colonies exhibit hybrid influences to some degree. Where the colonies are large the effect of mixing is scarcely apparent, but numerically small occurrences may be strongly influenced by infiltration. The prevalence of hybrids is not general in *Paryphanta* populations, but a local phenomenon caused in this instance by an imperfect water barrier in an area of large snail concentrations.

**Paryphanta lignaria rotella** Powell, 1938. Pl. 64, figs. 4 and 5.

1938. *Paryphanta unicolorata rotella* Powell, Rec. Auck. Inst. Mus. 2 (3), p. 137, Pl. 33, figs. 8 and 9.

1946. *Paryphanta unicolorata rotella* Powell, Rec. Auck. Inst. Mus. 3 (2), p. 107.

*Localities:* Between headwaters of St. Andrew's and St. George's Streams, tributaries of the Ngakawau, at 1,200 feet, western slopes of Glasgow Range, Buller (type); western slopes of Glasgow Range, 1,100-2,000 feet; north side of St. Andrew's Stream, on "pakihi," 1,300-1,400 feet (W. H. Johnston, A. C. O'Connor and A.W.B.P., Jan., 1947); ridge between Coal Creek and Chasm Creek, 700 feet (W. H. Johnston); ridge above the Hydro (State) Mine, Seddonville, 400-500 feet, map S. 23-24, ca. 448955 (W. H. Johnston, A. C. O'Connor and A.W.B.P., Jan., 1947).

The species occurs sparsely, mostly in silver pine "pakihi" areas, but is widespread on the higher slopes of the western drainage of the Glasgow Range. It penetrates to the lower levels down a leading spur to the vicinity of Seddonville, where it is a slight hybrid influence in the low level *unicolorata* colonies on the Seddonville Flat and between the Seddonville railway tunnel and Page's Creek.

A figure (pl. 64, figs. 4, 5) of a topotype shows the characteristic colour pattern more clearly than in the 1938 figured holotype.

**Paryphanta lignaria ruforadiata** n. subsp. Pl. 64, figs. 1 and 2.

This subspecies is of similar shape and size to *unicolorata*, but has a much darker ground colour (Brussels brown to raw umber, Ridgway, pl. 3) plus a radial pattern of broad, rather sparse, somewhat irregular, dark reddish-brown streaks, about nine on the body-whorl. Parietal callus bluish grey. Dorsal surface to periphery finely malleate-striate as in *unicolorata*.

Major diameter, 47.5 mm.; min. diam., 40.75 mm.; height, 29.0 mm. (holotype)

*Localities:* Five miles north of junction of north and south branches of Mokihinui River, on flat, 20 feet above river, in fairly open *Nothofagus* forest (type, W. Kelly, Feb., 1947); Two miles up Maori Gully, near North Branch of Mokihinui River (H. Wellman, 1948); North bank of Mokihinui River, $\frac{3}{4}$ mile above main highway bridge at St. Helens (W. H. Johnston, 1946) (4 typical and 13 hybrids, *unicolorata x ruforadiata*); North bank of Mokihinui River, $\frac{1}{2}$ mile above main highway bridge at St. Helens (W. H. Johnston, 1946); Between Sinclair and Stony Creeks, east side, South Branch of Mokihinui River, map S. 25, ref. ca. 645945 (F. Hughes, Dec., 1947) (one example, showing *unicolorata* influence). This is the actual locality from which Mr. E. De Malmanche obtained the specimen recorded in my 1946 paper (Rec. Auck. Inst. Mus. 3 (2), p. 106) as from Larrakin's Creek, on the authority of Mr. A. Richardson. The De Malmanche specimen is evidently a hybrid, *ruforadiata* x *unicolorata*, but a series will be necessary to determine the status of this colony. Mr. H. Wellman has recently traversed the Larrakin's Creek area without locating any snails.

The subspecies *ruforadiata* is present also as a hybrid influence in a number of colonies on the south side of the Mokihinui River through the gorge and between the railway tunnel and Page's Creek, below Seddonville (see locality list for *unicolorata*).

*Holotype:* Auckland Museum, presented by Mr. W. H. Johnston.

## Paryphanta lignaria johnstoni Powell, 1946. Pl. 65, fig. 9.

1946. *Paryphanta unicolorata johnstoni* Powell, Rec. Auck. Inst. Mus. 3 (2), p. 107, Pl. 9, figs. 3, 4.

*Localities:* West side of Chasm Creek towards junction with the Mokihinui River, 100-500 feet (W. H. Johnston, 1945) (type); 50 feet above Mokihinui River near road-railway crossing west of Seddonville Tunnel (W. H. Johnston); Maloney's Track from above Seddonville Tunnel to Trig AO, 1,352 feet, map S. 23-24, refs. 435980-411963, in "pakihi" and rain forest (W. H. Johnston, A. C. O'Connor and A.W.B.P., Jan., 1947); From Trig AO to Lowe Stream, tributary of Chasm Creek, 1,040 feet, at ca. 430948; near Charming Creek Coal Mine, east side of Creek, 500 feet, at ca. 408927 (W. H. Johnston, 11/2/1949); Ratcliffe Ridge (Radcliffe on maps), coastal range between Mokihinui and Ngakawau Rivers, vicinity of Trig AM, 1,749 feet, ca. 375938 (W. H. Johnston, R. A. Prouse, and A.W.B.P., April, 1948).

The species lives around the margins of "pakihis" as well as in the forest. It occurs in a number of scattered concentrations without apparent continuity.

Most examples from Ratcliffe Ridge have a striking bi-zoned base; plain khaki around the umbilicus, but over the rest of the base and top the deep red-brown spiral bands are so closely spaced that little of the ground colour shows. A small percentage have spaced narrow spiral bands and lines on a light ground as in the holotype. The Charming Creek Mine examples are typical, but those from the Trig AO-Lowe Creek traverse have narrow to faint lines on the base and approach *rotella*.

My 1946 (l.c. p. 108) forecast that *johnstoni* was likely to occupy the entire block bounded by the Mokihinui and Ngakawau Rivers, the sea and Charming and Chasm Creeks proves to be correct. There is an eastern infiltration into the *rotella* area at the Charming Creek Mine, and those from near Lowe Creek show considerable *rotella* influence, but the major part of the *johnstoni* area breeds true to type.

A figure (pl. 65, fig. 9) of a Ratcliffe Ridge example is given to show the maximum development of the *johnstoni* pattern.

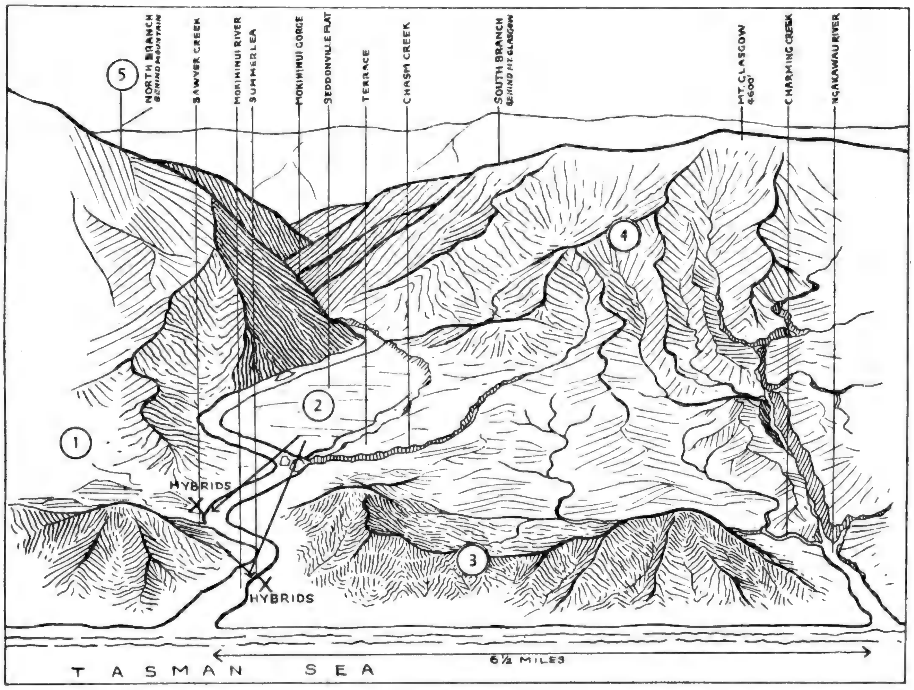
Collapsed and badly stained shells are abundant around the Burning Mine, Millerton, on the plateau to the south of the Ngakawau River. They have a *johnstoni* pattern of closely spaced, narrow lines plus broad radial dark streaks. The material, however, is too imperfect to evaluate this form. Neither Mr. Corbett, the finder of these snails, nor Mr. W. H. Johnston, have succeeded in locating living material.

### 1c. Hybrid Populations (lignaria x unicolorata).

I have already reported upon two significant hybrid colonies, *lignaria* x *unicolorata* (Powell, 1949, Trans. Roy. Soc. N.Z., Vol. 77 (5), pp. 203-206), one from Sawyer Creek Bend and the other from near the mouth of the Mokihinui River at Summerlea on the south bank. The

inference is that both hybrid populations owe their origin to the considerable displacement of snails that must have been occasioned by the big flood following the 1929 Murchison Earthquake.

The Summerlea colony (pl. 66, fig. 1) is of special interest, since both components, *lignaria* and *unicolorata,* do not normally occur in the area, but have been transported respectively from across the river in the case of *lignaria* and higher up on the Seddonville Flat in the case of *unicolorata.* The only large snail normally belonging to the block covering the Summerlea site is *johnstoni,* but it is restricted to higher ground.




TEXT FIG. A. Approximate diagram of Mokihinui West Coast, looking east from the sea. The numbered symbols are: 1 = *lignaria lignaria,* 2 = *lignaria unicolorata,* 3 = *lignaria johnstoni,* 4 = *lignaria rotella,* and 5 = *lignaria ruforadiata* n. subsp.

The Summerlea hybrids range from large-sized almost pure *lignaria* (64 mm.) to a few almost pure *unicolorata* (40-47 mm.). The bulk of the colony is made up of intermediate sized snails exhibiting sparse to moderate radial banding which is in the form of narrow dark-brown radials or broad reddish-brown radial streaks. Some forms almost approximate the subspecies *ruforadiata* from the North Branch of the Mokihinui.

The Sawyer Creek hybrids are numerically few and their influence is rapidly absorbed by the surrounding extensive *lignaria* population. These hybrids were observed only within about 400 sq. yds. and not more than 50 feet above river level, and only at this bend of the river which is favourably situated for the stranding of flood-borne snails.

Should the Summerlea colony continue to flourish and it escapes further large-scale infiltration by flood-borne stock, still another subspecic form may evolve.

Even upon the existing data it is fairly conclusively shown that new forms could arise from such rare accidents as the Murchison Earthquake flood.

Mayr, 1942 (Systematics and the Origin of Species, p. 263) gives some interesting observations on hybrid populations which apply to the "allopatric" forms (i.e., forms that are normally separated geographically) encountered in the Mokihinui River drainage.

Mayr (l.c., p. 263) states that if a geographic barrier is lifted any of four processes may occur: "(1) The two populations have, during the isolation, developed to full species, which are reproductively isolated and sufficiently distinct in their ecological requirements not to be close competitors. The lifting of the barrier will generally lead to a broad mutual overlapping of the ranges. (2) The two populations have developed to full species, which are reproductively isolated, but are closely competitive owing to non-development of sufficient differences in the ecological requirements. The result is a narrow overlap in a border zone . . . (3) The two populations have acquired different habitat preferences during their isolation, but not reproductive isolation. This results in a curious interlacing of ranges, with hybridization at the borders of habitats. (4) The two populations have not perfected either different habitat preferences or biological isolating mechanisms that would guarantee reproductive isolation and consequently will hybridize freely on coming into contact. In this case a more or less extensive hybrid population, a zone of secondary intergradation, will be formed in the area of contact."

From the above it is clear that the Sawyer Creek and Summerlea hybrid populations are covered by the fourth process. That is, the component forms are distinctive so long as they are kept apart, but since reproductive isolation has not obtained they will freely hybridise where the barrier falls down as in the case of these flood-mixed populations.

A partial ecological difference exists between the components—i.e., *unicolorata* belongs to the river flats, but *lignaria* occurs from sea level to the vicinity of 1,000 feet. This limits the possibility of hybridization to the low country, and thus the major area of the *lignaria* population is free from hybrid influence.

Since such apparently distinctive forms as the plain coloured *unicolorata* and the axially banded *lignaria* will freely hybridise when isolating factors cease to operate, it is reasonable to suppose that other more remotely situated forms would do likewise if brought together.

I have anticipated this revaluation in a footnote to my paper "The Species Problem in New Zealand Land Snails," Trans. Roy. Soc. N.Z. 77 (5), p. 205: "The separation between *lignaria* and *annectens* is absolute, but I have shown that *lignaria* and *unicolorata,* which under conditions of isolation are quite distinct both in colour and in form, will freely hybridise when brought together. It is likely, therefore, that a

reconsideration of values may result in the admission of fewer species and more subspecies and that my groups (i.e., *busbyi, traversi, hochstetteri, gilliesi, lignaria* and *rossiana*) will represent the species."

Mayr's first process, which covers two populations that have developed into full species during former isolation that no longer exists, is demonstrated by the distribution of two species of *Rhytida* in the Waitakere Ranges, Auckland. The species concerned are *greenwoodi,* mainly Auckland and south of Auckland, and *dunniae,* mainly north of Auckland. Fluctuation in the topography of the Manukau Estuary has evidently admitted *greenwoodi* to the northern area and both now have an irregularly interpolated distribution in the Waitakere area, but no hybrids have been observed.

## 2. THE ROSSIANA SERIES.

This group of snails consists of relatively small species, 30-40 mm. in diameter, very thin, composed almost entirely of chitin, dark greenish or brownish, radially streaked with darker brown and highly polished. They occur in a number of isolated localities at altitudes between 2,500 and 3,700 feet, mostly in tussock and above the bush line.

A former continuity is suggested, extending from at least the Otago Cold Lakes across to the western side of the Southern Alps and up to the Millerton and Denniston Plateau, north of the Buller. An occurrence at Kirwan's Hill, 3,500 feet, seven miles N.E. of Reefton (*P. cf. gagei,* Powell, 1938, Rec. Auck. Inst. Mus. 2 (3), p. 136), indicates that the Millerton-Denniston snails were derived via an inland route—Orikaka, Buller and Inangahua Rivers.

It is likely that the assumed once extensive distribution of these snails was largely obliterated by Pleistocene glaciation and that the group survived only under exceptional circumstances where the ice-sheet did not form a continuous cover. Mr. H. Wellman, to whom I am indebted for the idea, visualised the possibility, in the case of Mt. Greenland, of an outlier from the Alps which rose above or parted the assumed surrounding cover of ice. Some of the forms, *fletcheri* for instance, show a great tolerance for snow, which must cover the habitat for many months of the year.

Although the *rossiana* series show comparative uniformity in size, build and coloration, there is one significant point which separates them into two groups, and that is egg size. Mr. A. C. O'Connor (1945, Trans. Roy. Soc. N.Z. 75, p. 54) has shown that *spedeni* "is the 'kiwi' of the family" in that, like the bird, it produces an egg disproportionately large for the size of the parent. Thus the egg of *spedeni,* in contrast with that of the *rossiana* group, is actually the equal of that of *hochstetteri,* a very much larger snail.

In the light of modern evaluation of species and subspecies, especially the suggestion that geographic isolation does not necessarily mean reproductive isolation, the possibility of the actual or potential breaking down of barriers makes reconsideration of taxonomic values necessary. Although the existing barriers between all the *rossiana* forms appear to be absolute, there is no guarantee that reproductive isolation has

obtained and that artificial mixing of forms would not produce hybrids. Unfortunately the life span of these snails (probably 10-15 years) is too long for practical hybridization experiments.

On account of the strong upper surface striation, coupled with the egg size anomaly in *spedeni*, I consider it specifically distinct from *rossiana*, with which the remaining forms are associated as subspecies.

### LOCALITY KEY.

Southland, W. side Mataura River, 3,200 feet .................... *spedeni spedeni*
Southland, Billow Mts., 3,000 feet, S.W. of Lake Monowai .. *spedeni lateumbilicata*
Westland, Mt. Greenland, 2,900 feet, and Mt. Rangitoto, near Ross, *rossiana rossiana*
Westland, Mt. Tuhua, 3,688 feet, E. of Lake Kanieri .......... *rossiana fletcheri*
Grey, Seven Mile Stream, 2,800 feet, Rewanui, Greymouth ........ *rossiana gagei*
Inangahua, Kirwan's Hill, 3,500 feet, 7 m. N.E. of Reefton .... *rossiana* cf. *gagei*
Buller, St. Patrick Stream, 2,500 feet, Millerton and Denniston ........................................ *rossiana patrickensis*

### SYSTEMATIC KEY.

Egg large (11-11.5 mm.)
  Dorsal surface distinctly striated.
    Radials almost absent.
      Umbilicus one-tenth diameter ...................... *spedeni spedeni*
      Umbilicus one-eighth diameter ................ *spedeni lateumbilicata*

Egg small (6.5-8.5 mm.)
  Dorsal surface weakly striated.
    Radials inconspicuous.
      Umbilicus one-seventh diameter ................... *rossiana gagei*
  Dorsal surface smooth.
    Radials inconspicuous.
      Umbilicus one-ninth to one-tenth diameter ........ *rossiana rossiana*
      Umbilicus one-sixth diameter .................... *rossiana fletcheri*
    Radials conspicuous.
      Umbilicus one-seventh diameter .............. *rossiana patrickensis*

### **Paryphanta rossiana patrickensis** n. subsp. **Pl. 65, figs. 10-12.**

Shell small, thin, glossy, almost entirely chitinous, reddish-brown, with numerous radial dark-brown stripes; smooth and polished. Ground colour, varying through antique, argus and Brussels brown above and medal-bronze below (see Ridgway, pls. 3 and 4). The whole shell conspicuously but irregularly striped with narrow dark-brown radials, about 25 on the body-whorl. Between the dark-brown radials there are greenish-brown, faint to moderately strong, subsidiary axial stripes. Umbilicus one seventh major diameter of base.

Major diameter, 35.0 mm.; min. diam., 29.0 mm.; height, 21.0 mm.; depth of body-whorl opposite aperture, 15.5 mm.

*Localities:* Eastern side of Millerton Plateau, headwaters of St. Patrick Stream on fringe of "pakihi," map S. 23-24, ca. 356795, 2,500 feet (W. H. Johnston, R. A. Prouse and A.W.B.P., 8/4/1948). Very scarce, sheltering under tussock, on swampy ground. Vicinity of Denniston (W. R. B. Oliver, 1948). Between Denniston and Mt. Rochefort and Cedar Creek, S.E. of Denniston, ca. 325745 (W. H. Johnston, Sept.-Oct., 1949).

This subspecies differs from *fletcheri,* its nearest ally, in having a more distinct, regular and dense radial pattern of dark-brown stripes, a wider umbilicus (one-sixth major diameter in *fletcheri,* one-seventh in *patrickensis*), and a more elevated spire. In *rossiana* the spire is still more elevated, the umbilicus narrower, one-ninth to one-tenth the major diameter, and the shell is darker, with the radial stripes inconspicuous.

## 3. THE TRAVERSI SERIES.

In 1946 (Rec. Auck. Inst. Mus. 3 (2), pp. 115-122) I gave a detailed account of the *traversi* colonies which occur in the forest remnants of the Horowhenua Plain and in a few higher level basins of the foothills of the Tararua Range which flanks the eastern margin of the plain.

Once again I am indebted to Messrs. R. A. and H. S. Prouse, of Levin, for their valuable field work in the area. The lowland forest remnants have now been almost completely investigated and much of the foothills also.

Since my 1946 paper further work in these foothills has revealed several additional colonies and the necessity for nominating an additional form which, under present nomenclatural rules, is best designated as a subspecies.

**Paryphanta traversi latizona** n. subsp. Pl. 64, figs. 6-8.

Ground colour olive-lake to old gold, sparsely spirally banded, and zoned in mars-brown over the dorsal surface and periphery; rest of base consisting of very numerous closely-spaced thin spiral lines diffused into a dark area of approximately mummy-brown (Ridgway).

In 1946 (l.c. p. 118) I analysed a hundred examples from the type colony for this new subspecies, but did not differentiate the form from *traversi traversi.* Further collecting and a visit personally to the locality has convinced me that it is a high altitude subspecies developed in a small basin under conditions of comparative isolation from other colonies. My analysis was (DMPR 70% + DKPR 30%). These letter symbols used in my 1946 paper are as follows: D = Top more or less completely spirally lined and banded with light to dark reddish-brown. K = Base with very numerous narrow spirals generally diffused. M = Base almost uniformly dark warm-brown with occasional narrow spirals of the pale ground colour showing through towards the outer edge. P = Callus dull purplish-grey. R = Full size (50-55 mm.), showing marked acceleration of the last whorl.

The examination of some hundreds of examples shows this to be a very constant form always with broad spiral bands and zones, but averaging a smaller size than previously indicated, i.e., mostly from 40-43 mm.

Major diameter, 44.0 mm.; min. diam., 37.0 mm.; height, 26.0 mm. (holotype)

Major diameter, 44.0 mm.; min. diam., 37.0 mm.; height, 22.0 mm. (paratype)

The relationship of this subspecies is with *traversi* and *florida* rather than with *tararuaensis* from Kaihinu and Shannon Heights.

*Locality:* Greenaway's Bush, 700-800 feet, Arapaepae Range, west of Makahika Stream, tributary of Ohau River, Levin. Map N. 152, ca. 895015 (R. A. and H. S. Prouse and A.W.B.P., 1947).

The Arapaepae Range is an outlier from and parallel to the Tararua Ranges. To the west it is bordered by the Horowhenua Plain and to the east by the Makahika Stream. The *latizona* colony occurs in a small high level basin near the commencement of the range, amongst confused topography.

The drainage is to the west and south-west. The vegetation is rain forest with a dense undergrowth of ferns, especially *Blechnum discolor* and *Todea superba.*

Unfortunately the whole of Greenaway's Bush is likely to be cleared within the next few years.

**Paryphanta traversi tararuaensis** Powell, 1938.

1938. *Paryphanta traversi tararuaensis* Powell, Rec. Auck. Inst. Mus. 2 (3), 138, pl. 33, f. 2.

1946. *Paryphanta traversi tararuaensis* Powell, Rec. Auck. Inst. Mus. 3 (2): 120.

*Localities:* Kaihinu, Tararua Range, 1,500-2,000 feet, about four miles east of Tokomaru (type); East of and about 500 feet above Shannon Heights Basin, ca. 1,500 feet (R. A. and H. S. Prouse and A.W.B.P., Dec., 1946).

The second locality, 500 feet above Shannon Heights, produces a form of *tararuaensis* which in most individuals exhibits a more reddish top and a base rendered darker by more numerous and darker narrow spiral lines. The reddish dorsal surface is difficult to match with Ridgway's "Colour Standards" but seems to be approximately between madder-brown and hessian-brown.

There are two colonies near the southern edge of Shannon Heights Basin, ca. 1,000 feet, but these show *traversi* and *koputaroa* influences. They were probably derived from the plain, whereas the reddish-topped form from 500 feet above the Basin represents a southern extension of *tararuaensis.*

I now provide a figure of the holotype of *traversi koputaroa* (pl. 64, fig. 3). See Powell, 1946 (l.c.) p. 136.

**Genus RHYTIDA Albers, 1860.**

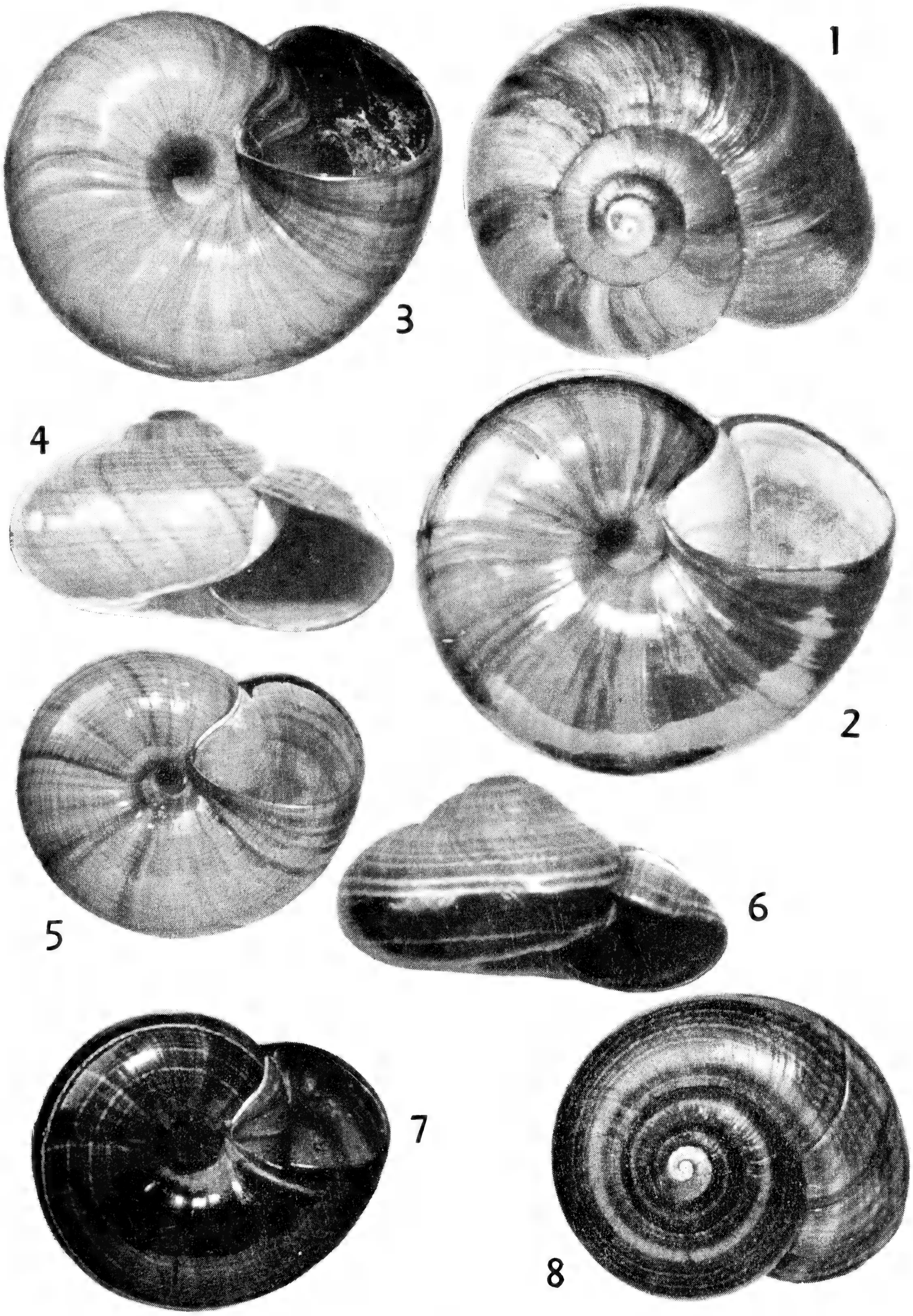
In Martens Helic. ed. 2, 89.

Type: *Helix greenwoodi* Gray.

As already noted (Powell, 1930 Rec. Auck. Inst. Mus. 1 (1), p. 29), shells from Auckland, the type locality, and most northern North Island occurrences have a dark chestnut umbilical zone. Shells from the southern part of the North Island and the related *stephenensis* from Stephen Island, Cook Strait, are without this zone.

Shells from the following localities have the umbilical colour zone: Auckland, slopes of Mt. Eden and Grafton Gully (Suter collection); Waiatarua, Waitakere Range, Muriwai West Coast, Auckland, and four miles south of Waiuku (A.W.B.P.); Oneroa, Palm Beach and Omiha, Waiheke Island, Moehau, Coromandel Peninsula and Taupiri Mountain (A.W.B.P.).

PLATE 64.




1. *Paryphanta lignaria ruforadiata* n. subsp. Paratype. 2. *P. lignaria ruforadiata* n. subsp. Holotype, 47.5 x 29.0 mm. 3. *P. traversi koputaroa* Powell, 1946. Holotype, 52.5 x 27 mm. 4. & 5. *P. lignaria rotella* Powell, 1938. Topotypes. 6-8. *P. traversi latizona* n. subsp. Holotype (6) and Paratypes, 44 x 26 mm.

Without the umbilical colour zone: Cuvier Island (Auck. Mus.); Fletcher's Bay, Cape Colville (A.W.B.P.); Waioeka Gorge, between Opotiki and Gisborne, Awakino Gorge and Mt. Messenger (A.W.B.P.); Wanganui (Suter collection); Waiapehu Reserve and other localities around Levin (A.W.B.P.).

Some coloured, others plain, in each colony (percentages refer to coloured form); Pukekohe, south of Auckland, 66% (Suter collection); Waikato Heads, 75% (W. La Roche); and Midhurst, Taranaki, 50% (Suter collection).

In general the plain form which may be taken as the more primitive is southern and the coloured form of northern distribution. A curious exception is the occurrence of a plain form at Cuvier Island.

There are four records of *Rhytida greenwoodi* from South Island localities: (1) Lake Guyon Run, near source of Waiau River (H. Suter, 1913, Man. N.Z. Moll., p. 775); (2) Takaka Valley, Nelson, a half-grown specimen collected by Dr. J. Henderson, 1922 (Powell, 1930, Rec. Auck. Inst. Mus. 1 (1), p. 29); (3) Left Bank of Lee, Wairoa Valley, Nelson, subrecent in cave, collected by Mr. F. V. Knapp (Powell, l.c. p. 29); and (4) on a talus-slope, subrecent? gorge of the Lower Waipara River, North Canterbury (R. S. Allan, 1937, Rec. Cant. Mus. 4 (3), p. 167).

The Lake Guyon specimen is not in the Suter collection, but I have re-examined the remaining three records, each based upon a single specimen. As far as can be judged on this scanty material, the reference to *greenwoodi* of the Lower Waipara example (25.75 mm. major diam. x 20.5 mm. min. diam.) is fairly certain, but the Wairoa Valley shell (24.5 mm. major diam. x 19 mm. min. diam.) is atypical in having seven strong, very widely spaced oblique spiral ridges which extend almost from the suture over on to the upper part of the base. It resembles a much larger fragmentary specimen (31.5 mm. major diam. x 26.5 mm. min. diam.) from a cave, "Takaka Mountains," Canterbury Museum. Both these subrecent shells, respectively, probably represent ancestral forms of *greenwoodi* and they are certainly distinct from the North Island subrecent species, *R. spelaea* (Powell, 1933, Proc. Malac. Soc. 20 (4), p. 192) from South of Cape Kidnappers. The Takaka half-grown shell has the coloration of the unicoloured North Island *greenwoodi* form, but a relatively higher spire.

Forms of *greenwoodi* are now so uncommon in the South Island that isolated occurrences have developed independent trends. The subspecies *webbi,* for instance, seems to be rare and extremely local.

**Rhytida greenwoodi webbi** n. subsp. **Pl. 65, figs. 16, 17.**

Shell of similar size and general appearance to *greenwoodi,* but with a more depressed spire, more vertically compressed whorls (see last two columns in table of measurements below) and only obsolescent oblique transverse ridges on the peripheral area of the last whorl. These ridges number five, as in *greenwoodi,* but in most examples they are too indefinite to be counted. The radial sculpture is exactly as in *greenwoodi*—closely spaced retractively oblique wrinkles, partly anastomosing, and forming an irregular network of elongated narrow meshes, especially on the dorsal surface.

Colour dark reddish-brown above and encroaching over the outer area of the base, rest of base yellowish to slightly greenish pale-brown and without an umbilical colour zone. Apertural and parietal callus pale purplish-brown, not bluish as in *greenwoodi*. Umbilicus between one-fifth and one-sixth major diameter of base.

| Major diam. | Min. diam. | Height. | Wh. th.* | |
|---|---|---|---|---|
| *greenwoodi greenwoodi* | | | | |
| 26.0 mm. | 20.5 mm. | 15.5 mm. | 9.5 mm. | Muriwai, W. Coast |
| 25.5 mm. | 20.0 mm. | 15.5 mm. | 9.5 mm. | Waikato Heads |
| 25.5 mm. | 20.4 mm. | 15.5 mm. | 9.75 mm. | Muriwai, W. Coast |
| 25.0 mm. | 19.75 mm. | 16.0 mm. | 9.5 mm. | Muriwai, W. Coast |
| 25.0 mm. | 20.5 mm. | 16.5 mm. | 9.0 mm. | Waikato Heads |
| 24.75 mm. | 20.0 mm. | 15.0 mm. | 9.5 mm. | Muriwai, W. Coast |
| 24.0 mm. | 19.0 mm. | 16.0 mm. | 9.5 mm. | Waikato Heads |
| 24.0 mm. | 19.5 mm. | 16.0 mm. | 9.5 mm. | Waikato Heads |
| *greenwoodi webbi* | | | | |
| 26.5 mm. | 20.25 mm. | 13.5 mm. | 8.5 mm. | (holotype) |
| 24.0 mm. | 19.0 mm. | 12.5 mm. | 8.0 mm. | (paratype) |
| 23.5 mm. | 18.9 mm. | 12.45 mm. | 8.0 mm. | (paratype) |
| 23.0 mm. | 18.25 mm. | 12.25 mm. | 8.0 mm. | (paratype) |

* = whorl thickness, a vertical measurement from suture to base, in line with axis of shell.

*Dentition:* The radula of *webbi* is practically identical with that of *greenwoodi* typical. The laterals increase rapidly to the tenth, which is very large and massive, the vestigial eleventh is minute and ill-formed, and the central is only two-thirds the height of the nearest lateral. The largest lateral in the *greenwoodi* series lacks the median ridge of the *patula* series. The formula is 11 + 1 + 11, compared with 12 + 1 + 12 in the Waiuku example of *greenwoodi* typical (Powell, 1930, p. 28, text fig. 5), but the number and size of these vestigial outer laterals are subject to variation, as instanced by another Waiuku example which has only one vestigial lateral as in *webbi*.

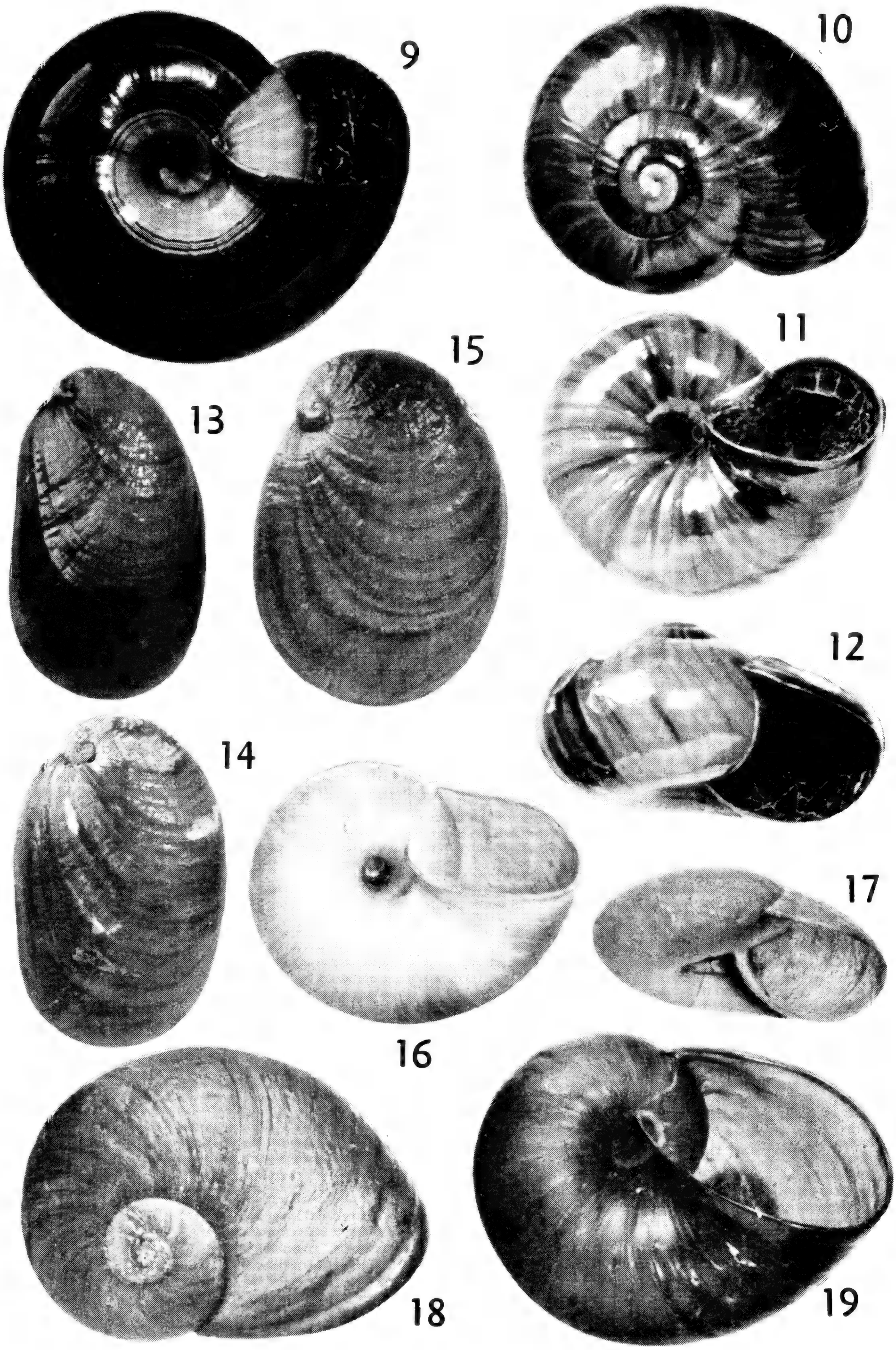
*Locality:* Clifton, Takaka, Nelson. Under clumps of *Astelia* amongst limestone. A. C. O'Connor, January, 1945. Rare and apparently very local.

This subspecies is named in honour of Mr. Eric Webb, of Takaka.

*Holotype:* In Auckland Museum.

**Rhytida hadfieldi** n. sp. Pl. 65, figs. 18, 19.

Shell large, thin, translucent, largely chitinous, depressed, of $3\frac{3}{4}$ rapidly increasing whorls. Aperture very large, oblique, elongate-oval. Umbilicus deep, one-seventh to one-ninth the major diameter. Protoconch of $1\frac{1}{2}$ almost flat, finely radially ribbed whorls. Post-nuclear whorls finely malleated by a laterally compressed network of anastomosing radial ridges. The whole surface covered with exceedingly fine and dense wavy spiral striations. Seven to nine subobsolete, slightly oblique spiral ridges or folds at the periphery, too indefinite to be accurately counted. Colour, dark reddish-brown. A juvenile is light brown on the base, but with a dark reddish-brown zone in the umbilicus.




9. *Paryphanta lignaria johnstoni* Powell, 1946. Ratcliffe Ridge. 10-12. *P. rossiana patrickensis* n. subsp. Holotype (10) and Paratypes, 36 x 21 mm. 13. *Schizoglossa novoseelandica* (Pfeiffer, 1862), Toko, near Stratford, 20 x 12.10 x 6 mm. 14. *S. novoseelandica barrierensis* n. subsp. Holotype, 20 x 13.25 x 6.25 mm. 15. *S. worthyae* n. sp. Holotype, 21.5 x 15.5 x 6 mm. 16, 17. *Rhytida greenwoodi webbi* n. sp. Holotype, 26.5 x 13.5 mm. 18, 19. *Rhytida hadfieldi* n. sp. Holotype (19) and Paratype, 32.4 x 18 mm.

| Major diameter. | Minimum diameter. | Height. | |
|---|---|---|---|
| 32.4 mm. | 24.0 mm. | 18.0 mm. | (*hadfieldi*, holotype) |
| 33.0 mm. | 25.0 mm. | 18.5 mm. | (*hadfieldi*) |
| 30.0 mm. | 23.0 mm. | 18.5 mm. | (*oconnori*) |
| 26.3 mm. | 21.0 mm. | 16.0 mm. | (*oconnori*) |
| 23.0 mm. | 16.3 mm. | 12.0 mm. | (*patula*, holotype) |
| 20.0 mm. | 15.0 mm. | 12.0 mm. | (*patula*, West Nelson) |

*Dentition:* 16 + 1 + 16, laterals increasing to the fifteenth, which is very large and medially ridged, sixteenth very small with a poorly developed cusp.

*Localities:* Canaan, near headwaters of the Wainui River, Pikikiruna Range, Nelson (A. C. O'Connor, Jan., 1949). Awarua Bay, near Separation Point, Nelson, almost at sea-level (W. V. Hadfield and A. C. O'Connor, Feb., 1949).

A member of the *patula* group of species which includes, besides *patula, citrina, oconnori, meesoni, meesoni perampla, otagoensis,* and probably *australis.* They have very thin, almost entirely chitinous shells with rapidly increasing whorls resulting in a large, elongately oval aperture. A characteristic of the radula is the median ridge on the largest lateral.

The new species combines the shape of *patula* with the large size of *oconnori.* Compared with *patula* and *citrina, hadfieldi* has one and a half times the linear dimensions, is of a much darker brown colour and has a dental formula 16+ 1 + 16, which is the same as in the yellowish-olive coloured *citrina.* The formula for *patula* is 18 + 0 + 18. From the large sized subfossil *oconnori* from Punipaua Creek, West Nelson (Powell, 1946, Rec. Auck. Inst. Mus. 3 (2), p. 130), *hadfieldi* differs in having a wider umbilicus, more loosely coiled whorls, and only obsolescent peripheral ridges. In *oconnori* the umbilicus is one-thirteenth to one-fourteenth the major diameter of the base, compared with one seventh to one-ninth in *hadfieldi.*

The species is named after Mr. W. V. Hadfield, of Awarua Bay, Takaka, who forwarded to me some years ago a damaged specimen of this species found in a swamp.

## Genus **SCHIZOGLOSSA** Hedley, 1892.

Proc. Linn. Soc. N.S.W. (2) 7, p. 30.

Type (monotypy): *Daudebardia novoseelandica* Pfeiffer.

Two distinct forms of Recent *Schizoglossa* have long been known to me and each is apparently a descendant of a much larger Pleistocene or post-Pleistocene species, i.e., *S. gigantea* Powell, 1930, and *S. major* Powell, 1938.

The distribution of the broadly ovate Recent *Schizoglossa* is Patumahoe, south of Auckland, north to Hokianga and eastward to near Paeroa. Its fossil ancestor is from Pukemiro, about 60 miles south of Auckland.

The distribution of the narrow oblong Recent *Schizoglossa* is Waitomo, southwards to Taupo, Taihape and Wanganui, and westward to Taranaki. Its fossil ancestor is from the Gisborne district. The genus is nowhere common, and the sporadic locality records are probably due to lack of intensive collecting.

A third Recent form occurs at Tryphena, Great Barrier Island, and its relationship, strangely, is with the narrow oblong form.

The diffiulty now arises—which form represents the typical species?

Pfeiffer's description of his *novoseelandica* (1898, Monog. Helic. Viv. 5, p. 10) is as follows:—

"T. imperforata, depressissima, ambitu ovalis, solidula, striis incrementi distinctis et lineis impressis radiantibus sculpta, fulva; spira minima, $\frac{1}{8}$ longitudinis occupans; anfr. $2\frac{1}{2}$ ultimus latere subcompressus; columella superne crasse callosa; apertura oblonga, intus submargaritacea.—Long. 10, diam. 7, alt. $2\frac{1}{2}$ mill. (Coll. Nr. 4). Habitat in Nova Seelandia (Hochstetter)." Pfeiffer did not figure the species.

The following table gives dimensions of series representative of the three Recent forms and the two fossil species:—

(A) The broadly ovate form.

1. Recent. All from Mauku, near Patumahoe.

| Length. | Diameter. | Thickness. |
|---|---|---|
| 8.75 mm. | 6.00 mm. | 3.00 mm. |
| 10.10 mm. | 7.40 mm. | 3.15 mm. |
| 12.40 mm. | 9.40 mm. | 3.60 mm. |
| 15.50 mm. | 10.00 mm. | 4.70 mm. |
| 18.30 mm. | 13.25 mm. | 4.75 mm. |
| 22.00 mm. | 15.50 mm. | 5.50 mm. |

2. Subrecent. Pukemiro (*S. major*).

| | | |
|---|---|---|
| 36.00 mm. | 26.00 mm. | 8.50 mm. |

(B) The narrow oblong form.

3. Recent. Southern North Island.

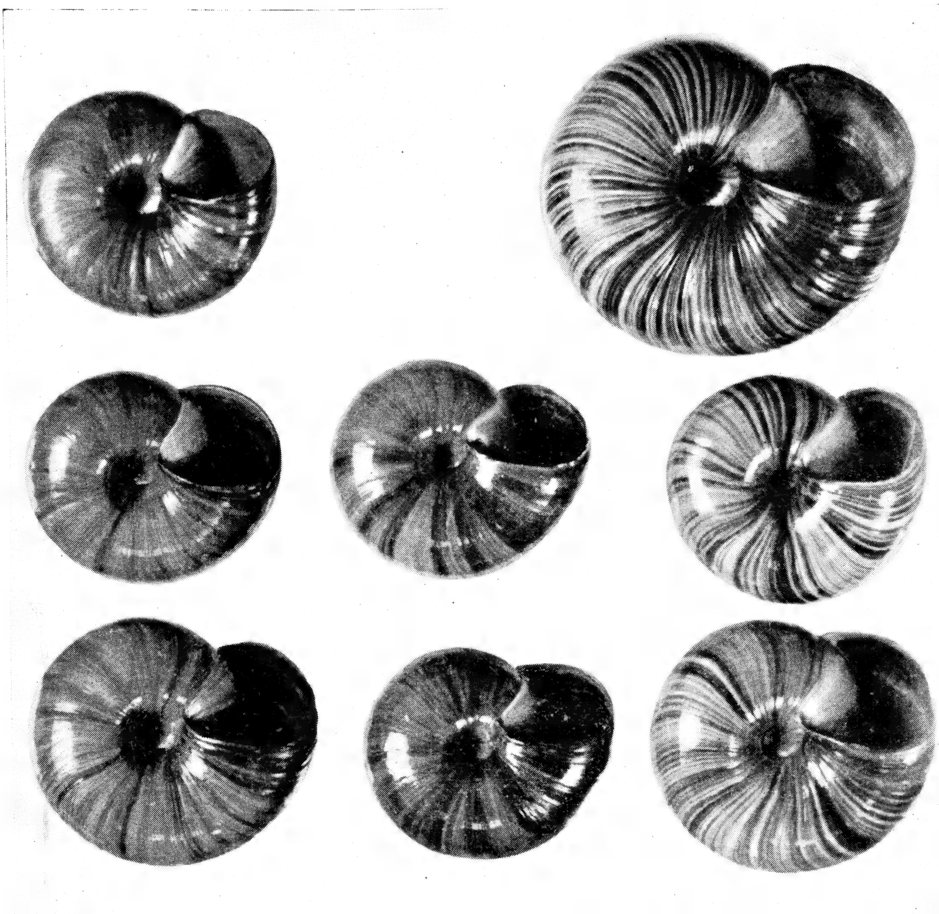
| | | | |
|---|---|---|---|
| 5.80 mm. | 4.00 mm. | 2.00 mm. | Atene. |
| 7.20 mm. | 5.10 mm. | 2.25 mm. | Atene. |
| 10.30 mm. | 6.60 mm. | 2.60 mm. | Toko. |
| 15.60 mm. | 9.50 mm. | 4.50 mm. | Toko. |
| 20.00 mm. | 12.10 mm. | 6.00 mm. | Toko. |

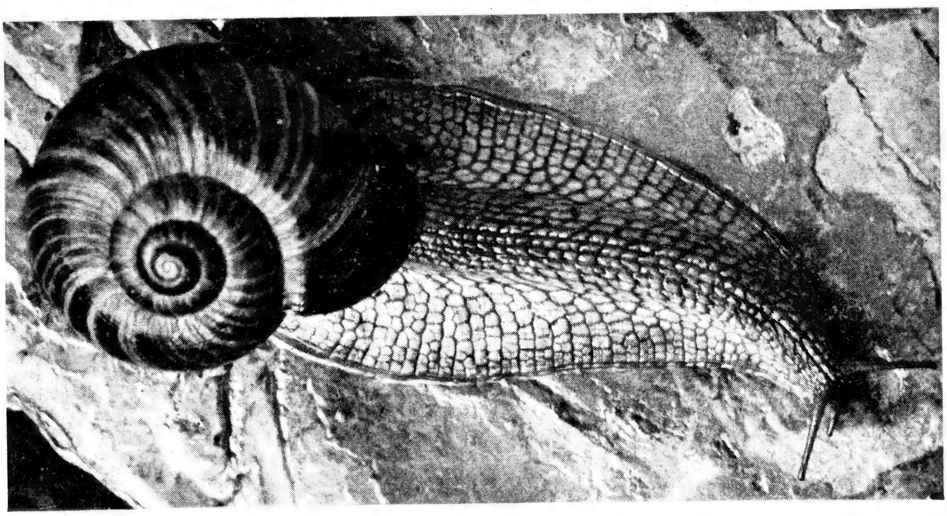
4. Recent. Great Barrier Island.

| | | |
|---|---|---|
| 6.25 mm. | 4.25 mm. | 2.0 mm. |
| 14.50 mm. | 9.50 mm. | 3.5 mm. |
| 20.00 mm. | 13.25 mm. | 6.25 mm. |

5. Subrecent. Tahora, Gisborne (*S. gigantea*).

| | | |
|---|---|---|
| 32.00 mm. | 19.00 mm. | 6.00 mm. |





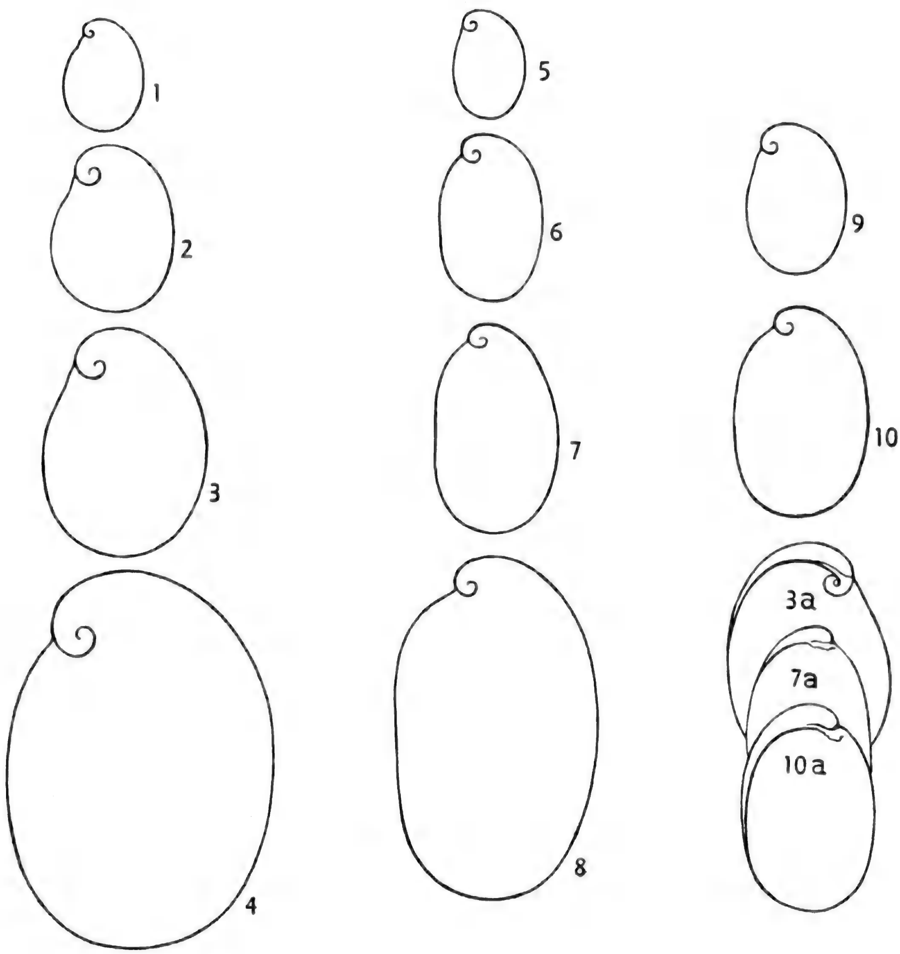
Above: Summerlea hybrids (*lignaria* x *unicolorata*); *unicolorata* dominant (top left); *lignaria* dominant (top right).

Below: *Paryphanta lignaria lusca* n. subsp. Glass-Eye Creek, Mokihinui-Karamea Road, with animal fully extended.

Wm. C. Davies, Photo.

Unfortunately Hochstetter's species seems to be extinct at the type locality, which is Kakepuku Mountain, Waikato, and neither the type specimen nor any material from reasonably near the type locality is available to me.

Pfeiffer's description, however, although brief, indicates the narrow oblong form as true *novoseelandica.* The significant points are the height in relation to the length and diameter (especially in young to half-grown examples), the spire occupying one-eighth of the length and the impressed linear sculpture.




TEXT FIG. B. *Schizoglossa.* 1-3. *worthyae* n. sp. 4. *major* (holotype). 5. *novoseelandica* (Ohakune). 6. *novoseelandica* (Taihape). 7. *novoseelandica* (Toko). 8. *gigantea* (holotype). 9, 10. *novoseelandica barrierensis* n. subsp. (All uniform scale.)

The broadly ovate form has the spire about one-fifth of the length, it is thicker or higher, and the sculpture is more irregularly-malleated than incised-linear. It is described following as a new species, *worthyae,* and is obviously descended from the large subrecent *major.*

The Great Barrier shells described below represent a new local subspecies of *novoseelandica*, and they in turn are clearly Recent derivatives of the subrecent *gigantea*.

The difference between the narrow oblong and the broadly ovate form is much more marked in the subrecent species than in their respective descendants, but since the divergence is of long standing it is more natural to accept specific rather than subspecific distinction in respect to the Recent shells.

**Schizoglossa major** Powell, 1938. Text fig. B4.

1938. *Schizoglossa major* Powell, Rec. Auck. Inst. Mus. 2 (3), p. 139, pl. 33, figs. 15, 16.

*Locality:* Subrecent, in limestone crevice with "moa" remains, ½ mile S.W. of Pukemiro, Waikato, North Island.

(See table (A) 2, for dimensions.)

*Holotype:* Auckland Museum.

**Schizoglossa worthyae** n. sp. Pl. 65, fig. 15; text figs. B1-3, 3a.

1913. *Schizoglossa novoseelandica:* Suter (in part, not of Pfeiffer), Man. N.Z. Moll., p. 785.

1930. *Schizoglossa novoseelandica:* Powell (not of Pfeiffer), Rec. Auck. Inst. Mus. 1 (1), pl. 1, figs. 3, 4.

Shell auriform and depressed, much smaller than the animal, consisting of a thin, limy, broadly ovate shell, covered with a moderately thick olive-brown chitinous epidermis, grading to greenish-yellow at the margins. The surface is malleated by irregular wavy radiate striations. Concentric growth stages are clearly marked, somewhat ledged and defined by darker brown. Protoconch of 1½ convex smooth brownish whorls. The spire occupies from one-fourth to one-fifth the length of the shell.

Length, 21.5 mm.; diameter, 15.5 mm.; thickness, 6.0 mm. (holotype) (see table (A) 1, for range of dimensions).

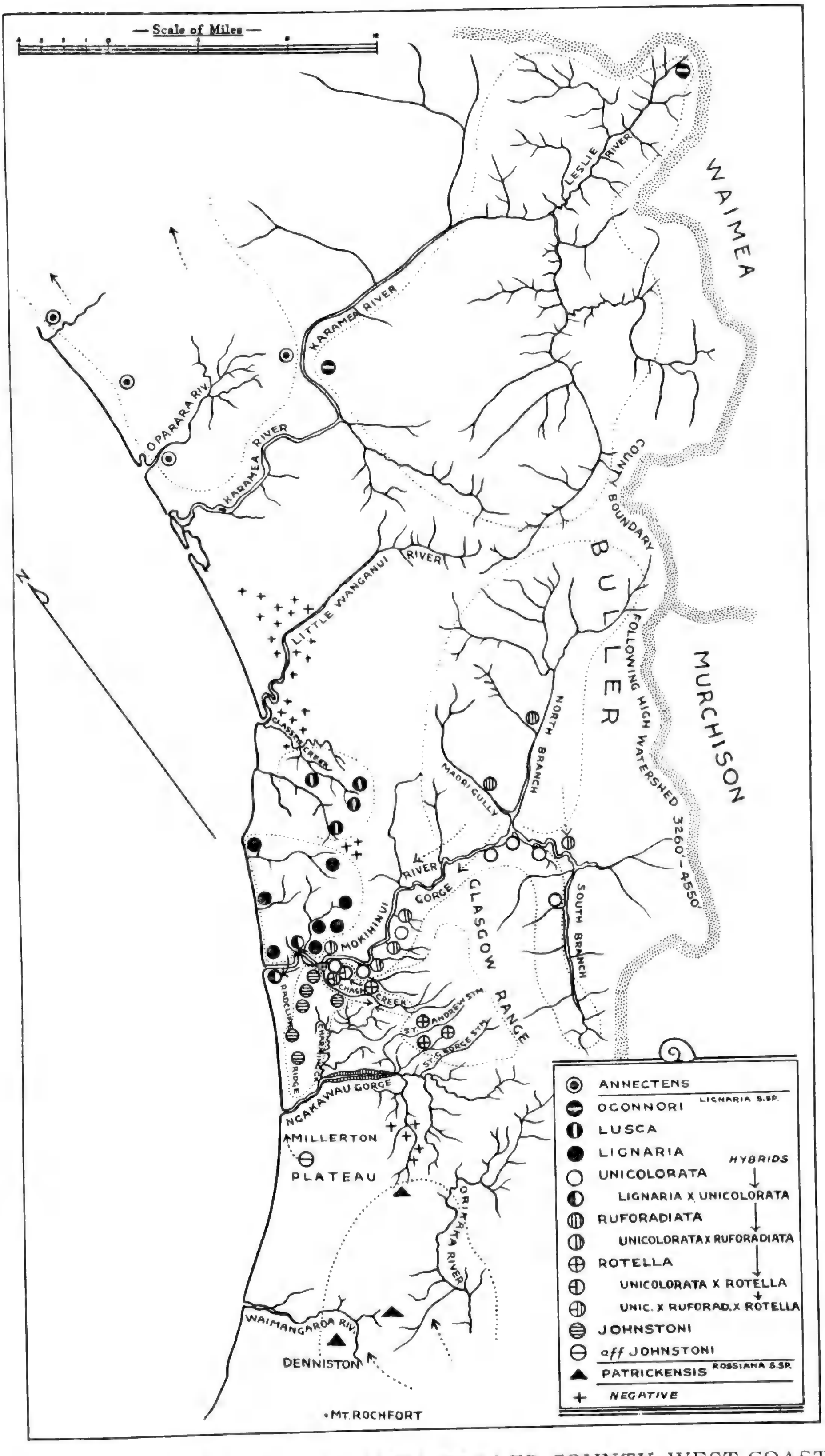
*Localities:* Mauku, near Patumahoe, South Auckland (type, Mrs. I. Worthy, 1947); South slope of Manaia, Whangarei Heads (A.W.B.P., 2/11/1919); Broadwood, Hokianga (Mr. R. Wynter); Karangahake Hill, 1,300 feet, near Paeroa; Tauranga side of Kaimai Range (A. E. Brookes); Mamaku, near Rotorua.

*Eggs:* Broadly elliptical, white and without a cuticle—4.25 x 3.5 and 4.5 x 3.5 mm. (See O'Connor, 1945, Trans. Roy. Soc. N.Z. 75, p. 54).

*Radula:* 26 + 0 + 26, Manaia, Whangarei Heads (Powell, 1930, l.c. p. 23, text fig. 2S). The laterals vary in number between 25 and 28. There is no apparent difference between the dentition of *worthyae* and *novoseelandica*.

*Holotype:* Auckland Museum.

The shell differs from that of *novoseelandica* in its more broadly ovate outline, relatively greater thickness or height, larger spire in relation to length, malleate sculpture and visible umbilicus, not overshadowed




DISTRIBUTION OF PARYPHANTA, BULLER COUNTY, WEST COAST.

by the parietal wall. The subfossil *major* is clearly ancestral to *worthyae*. It is more regularly ovate than *worthyae* and much larger and more massive.

Named in honour of Mrs. I. Worthy, of Patumahoe, to whom I am indebted for the type series of specimens.

**Schizoglossa gigantea** Powell, 1930. Text fig. B8.

1930. *Schizoglossa gigantea* Powell, Rec. Auck. Inst. Mus. 1 (1), p. 54, pl. 1, figs. 5, 6.

*Localities:* Subrecent with "moa" bones, cave near Tahora, Gisborne District (type); Caves at Waikaremoana, and Mangaone Cave near Nuhaka, Hawke's Bay (H. Hill, 1933).

(See table (B) 5, for dimensions.)

*Holotype:* Powell collection, Auckland Museum.

This species differs from the other narrow oblong forms in being relatively much more depressed.

**Schizoglossa novoseelandica (Pfeiffer), 1862. Pl. 65, fig. 13; text figs. B5-7, 7a.**

1862. *Daudebardia novoseelandica:* Pfeiffer, Mal. Bl. 8, p. 146.

1868. *Daudebardia novoseelandica:* Pfeiffer, Monog. Helic. Viv. 5, p. 10.

1892. *Schizoglossa novoseelandica:* Hedley, proc. Linn. Soc. N.S.W. (2) 7, p. 387, pl. 9, figs. 1-3.

1913. *Schizoglossa novoseelandica:* Suter, Man. N.Z. Moll. (in part), p. 785.

*Localities:* Kakepuku Mountain, Waikato (type); entrance to glow-worm cave, Waitomo (A.W.B.P., Jan., 1949); Otonui, near Taumarunui (J. Peek); near Pio Pio (A.W.B.P., 1927); Pukemako, west side of Lake Taupo (A. C. O'Connor); Ohakune (P. C. Gardner); Taoroa, near Taihape (A. C. O'Connor); Atene, near Wanganui (A. C. O'Connor); Whangamomona, Taranaki (Miss L. B. Moore); Toko, near Stratford (Suter Coll.).

Length, 20.00 mm.; diameter, 12.10 mm.; thickness, 6.00 mm. (largest example).

(See table (B) 3, for range of dimensions.)

*Eggs:* Broadly elliptical without cuticle, not distinguishable from those of *worthyae*—4.5 x 3.5; 4.5 x 3.75; 4 x 3.25 mm. (See A. C. O'Connor, 1945, Trans. Roy. Soc. N.Z. 75, p. 54.)

*Holotype:* K. K. Hofmuseum, Vienna.

**Schizoglossa novoseelandica barrierensis** n. subsp. **Pl. 65, fig. 14; text figs. 9, 10, 10a.**

Shell oblong-ovate with a small spire about one-seventh the length, sculptured with radial slightly flexuous impressed linear striations, not malleated. The umbilicus is overshadowed by the parietal callus. The outline is similar to that of the typical species except that the shell is relatively wider and is not narrowly contracted anteriorly.

Length, 20.00 mm.; diameter, 13.25 mm.; thickness, 6.25 mm. (holotype). (See table (B) 4, for range of dimensions.)

*Locality:* Tryphena, near divide between west and east coast, Great Barrier Island (C. Osborne, April, 1924).

*Holotype* and two paratypes, Powell collection, Auckland Museum.

# New Species of Crustacea from New Zealand of the Genera Scyllarus and Ctenocheles with Notes on Lyreidus tridentatus

By A. W. B. POWELL, Assistant Director.

**Abstract.**

Two new species of decapod crustacea trawled in northern New Zealand waters. They are *Scyllarus aoteanus* n. sp. nearest allied to the Tasmanian *mawsoni* Bage and *Ctenocheles maorianus* n. sp. which resembles *collini* Ward from South Queensland. Both genera are new additions to the New Zealand fauna. The paper concludes with a number of Bay of Plenty deep water records of the crab *Lyreidus tridentatus*.

## DECAPODA.

### Family SCYLLARIDAE.

### Genus SCYLLARUS Fabricius.

1775. Syst. Ent. p. 413. = *Arctus* Haan, 1849, in Siebold, F. Japon (Crust.), p. 238, = *Arctus* Dana, 1852, Proc. Acad. Nat. Sci. Phil. 6, p. 14.

**Scyllarus aoteanus** n. sp. Pl. 68, figs. 1, 2.

This species closely resembles *mawsoni* (Bage, 1938, and Hale, 1941), from 122 metres off Maria Island, Tasmania, and *sordidus* Stimpson (Bate, 1888), from Hong Kong.

All three have an almost identical intricate arborescent sculptural pattern on the abdominal somites. The chief difference between *mawsoni* and *aoteanus* is shown in the profile of the midline of the carapace. The former shows the fourth of the midline spines very prominent, the second one less than half its development, and numbers one and three smaller again. In the latter, all four are of about equal size and not prominent. One and two are single spines, but three and four are paired.

The carapace again provides the chief differentiating criteria between *sordidus* and *aoteanus*. In the former each lateral margin is laciniated by three equally strong spiny projections. In the latter only the upper two spines are prominent and the whole length of the margin is denticulated by lesser spines. The spiny sculpture on the dorsal surface of the carapace is much nearer to that of *mawsoni* than to that of *sordidus*.

*Description of holotype (male)*

Carapace very thick, strongly sculptured in definite areas by tubercles and sharply-pointed, broad-based spines. Gastral ridge tuberculated by a double row of low rounded tubercles with a third row interpolated towards the lower margin. Lateral margins studded with

17 irregular low denticles, median ones resembling human molars, in addition to two spiny projections, one above and the other below the eye. Mid-line of carapace with a single broad-based spine in front; second spine with a subsidiary spine on each side; third and fourth series double medially, fourth with subsidiary groups of spines on each side and below.

Abdominal somites very elaborately sculptured in arborescent patterns. Telson with two prominent wide-spaced calcareus spines; membranous remainder square ended.

Appendages characteristic of the genus. First pair of antennae with a wide basal joint, remaining joints slender. Second pair of antennae fan-shaped. First joint small, second with one large and one small spine, third fan-like with two prominent cusps on the outer side of the main diagonal cusp and four on the inner side, fourth and last joint with six large cusps and a small one on the inner margin.

*Colour:* Uniformly pale creamy-buff.

*Dimensions (Holotype):* Total length 89 mm. Carapace: Length in mid-line, 27 mm.; breadth of frontal margin, 26.5 mm.; breadth between orbits, 18 mm.; breadth at posterior border, 22 mm.

*Holotype:* Auckland Museum.

*Locality:* Houhora Beach, Northland, New Zealand (Captain H. M. S. Ryder, 1931) (Holotype); 20 fathoms off Port Fitzroy, Great Barrier Island (54 mm., total length).

## Family CALLIANASSIDAE.

### Genus CTENOCHELES Kishinouye.

1926. Annot. Zool. Jap. 11, p. 63. Type: *C. Balssi* Kish. Ohsu, Japan.

**Ctenocheles maorianus** n. sp. Pl. 68, figs. 3-7.

This species closely resembles *C. collini* (Ward, 1945), from Mud Island, Moreton Bay, Queensland. The most noticeable difference lies in the chelipeds, the left one in particular having long rake-like fingers, much more produced than in either *balssi* or *collini,* but not so extremely long and slender as in *Thaumastocheles.*

*Description of holotype (male)*

The whole animal is very lightly calcified; long and slender, with sides subparallel, compressed laterally. Carapace long and narrow, keeled medially and with a small rostral spine; gastric region more strongly calcified than rest of carapace. Abdominal somites narrowly rectangular, smooth, all but last very lightly calcified. Sixth somite and telson relatively strongly calcified.

Chelipeds unlike, the left one slightly the larger. In *collini* the right chela is very much larger than the left.

Left chela with an ovate-globose palm and very long slender fingers, twice the length of the palm, furnished with long slender interlocking teeth, about 30 in number, eight of which are primaries of about $2\frac{1}{2}$ times the length of the intermediates.

Right chela with an elongate-rectangular palm and short stout fingers about the same length as the palm, furnished with about 20 blunt, ill-formed teeth, about seven of which are more or less regularly spaced primaries. There is very little difference between the primary and secondary teeth, which are minute compared with the long, sharp, slender teeth of the left chela.

The opthalmopoda are relatively conspicuous, flattened, oblong plates lying together and projecting in front of the rostrum. The front proximal edges are pointed. The site of the eye is shown by a raised surface at about the front third of the upper surface. The eyes are not pigmented and do not seem to reach the surface, so presumably the animal is blind.

Antennules stout, two-thirds the length of the slenderly tapered second antennae. Other appendages characteristic of the genus.

*Colour* (in alcohol): buff; chelipeds with the palms pink or brownish tinged.

*Dimensions (Holotype):* Total length (rostrum to end of telson), about 112 mm. Carapace: Length, 27 mm.; width, 10 mm. anteriorly, 11 mm. posteriorly; maximum depth, 12.5 mm. Sixth somite: Length, 17 mm.; width, 11 mm. Left chela: 35 mm; dactylos, 22 mm. Right chela: 27.5 mm.; dactylos, 14 mm. Left chela: 38 mm.; dactylos, 25 mm. (Plate Island).

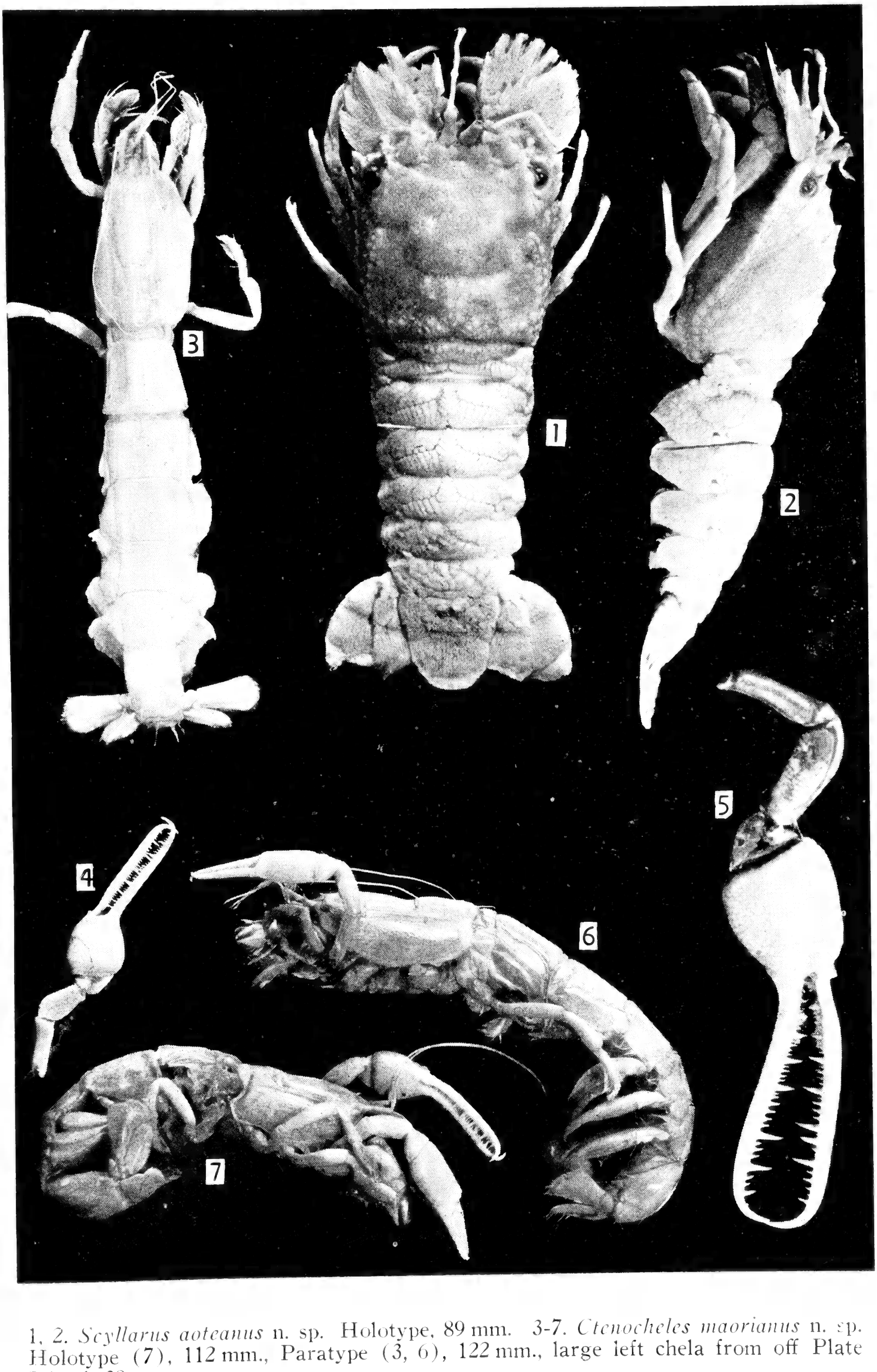
*Holotype:* Auckland Museum.

*Localities:* Trawled, Hauraki Gulf (C. Daniel, 1934) (Holotype); 19-20 fath., 8 miles E. of Tiri Tiri Island, Hauraki Gulf (F. Flinn, 4/9/1930) (left chela missing); 30 fath. off Plate Island, Bay of Plenty (S. Voss, 1949) (left chela); Tasman Bay, Nelson ( W.V. Hadfield, 1949) (left chela).

*Remarks:* A well preserved example, 122 mm. in length, minus the larger chela, is in the Auckland Museum collection, but has no data. It is apparently a male, and differs from the other material in having the left chela as the smaller one.

The species is apparently a deep burrower in soft mud, for chela are frequently torn off by trawl nets, but the dislodgement of a complete animal is of rare occurrence.

External sex characters are difficult to determine with certainty, and I am loath to dissect any of the three reasonably complete animals at my disposal.




1, 2. *Scyllarus aoteanus* n. sp. Holotype, 89 mm. 3-7. *Ctenocheles maorianus* n. sp. Holotype (7), 112 mm., Paratype (3, 6), 122 mm., large left chela from off Plate Island, 38 mm.

## BRACHYURA.

### Genus LYREIDUS de Haan.

1841. In Siebold F. Japon (Crust.), p. 140. (Type: *L. tridentatus* de Haan).

### **Lyreidus tridentatus** de Haan

1841. *Lyreidus tridentatus* de Haan, in Siebold, F. Japon (Crust.), p. 140.

1933. *Lyreidus australiensis* Ward, Austr. Zool. 7 (5), p. 377.

1947. *Lyreidus* sp. Powell, Rec. Auck. Inst. Mus. 3 (3), p. 170.

1949. *Lyreidus australiensis:* Richardson & Kreft, "Tuatara," Vict. Un. Coll., Wellington, p. 69.

The record of this handsome gymnopleuran crab, made by Richardson and Kreft (1949) from the Cook Strait area, on the basis of material found in the stomach of a dogfish, can now be amplified by the following series of occurrences from the continental shelf in the Bay of Plenty.

*Localities:* West of Alderman Islands, 50 fathoms (H. C. Hopkinson, March, 1946); N.E. of Motiti Island, 49 fathoms, Bay of Plenty; mud bottom (J. Shirley, 1946); Between Mayor Island and Motiti Island, 70-100 fathoms (S. Voss, June, 1949); Seven miles S.E. of Whale Island, Bay of Plenty; mud bottom (S. Voss, 21/4/1948); Waikawa Point, near Cape Runaway, 60 fathoms (S. Voss, Aug., 1949) (female "in berry").

*Remarks:* The genotype is from Japan and the species is evidently wide ranging down the margin of the Western Pacific.

Mr. Frank McNeill, Australian Museum, Sydney, considers that Ward's *australiensis* is inseparable from the genotype, and in support of this statement quotes Sakoi, 1937, Studies on the Crabs of Japan II, Rep. Tokyo Bunrika Daigaku, Sect. B., Suppl. 2, p. 168: "*L. australiensis* Ward was substituted for *L. tridentatus*, reported by Haswell from the sea of Australia in the earlier period, but the discriminations enumerated by Ward between *australiensis* and *tridentatus* are artificial and I am at a loss how to discriminate these species."

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HALE, H. M., 1941.—Decapod Crustacea. B.A.N.Z.A.R.E. Rep. Ser. B, 4 (9), p. 272, pl. 3, figs. 1 and 2.

RICHARDSON, L. R. & KREFT, S., 1949.—Lyreidus australiensis from Cook Strait, p. 69.

WARD, M., 1945.—A New Crustacean. Mem. Qsld. Mus. 12 (3), p. 134, pl. 13.

# A Second Record of a King-Crab from New Zealand Waters

By A. W. B. POWELL, Assistant Director.

The first recorded living example of a king-crab from New Zealand waters was published by Chilton in 1910. This example, which is in the Auckland Museum, was obtained by Mr. T. F. Cheeseman about 1908, who described the specimen as having been taken alive adhering to the stone facing of the Calliope Dock, Auckland. It was noted that no vessel had been in the dock for some considerable time. Mr. Cheeseman's identification of the specimen, based upon Pocock's 1902 revision, was *Carcinoscorpius rotundicauda* (Latreille), a species known from the Gulf of Siam, the Molluccas and the Philippines.

A second living king-crab was found on low tidal rocks at Katherine Bay, Great Barrier Island, about 1940 by Miss Freda Vera Davies, Motairehe, Great Barrier Island. This specimen is a male of the East American *Limulus polyphemus* Linn. It measures 315 mm. in total length, tail 133 mm. and maximum width of the cephalothorax 140 mm. The form of the genital operculum is exactly as figured by Pocock (1902, pl. 5, fig. a) for *polyphemus*. The long slender chelicera and weakly spinose crest to the tail are identical with these features in examined specimens of *polyphemus* from Massachusetts. A careful comparison between the Great Barrier Island example and those from Massachusetts reveals no points of difference.

Undoubtedly both of these New Zealand examples came by means of shipping, but it is difficult to imagine how such a large creature could remain attached to a ship's hull during such lengthy voyages as instanced by the first record of an East Indian species and the second of one from Eastern America. It is worthy of note, however, that a living *Limulus polyphemus* was found in Copenhagen Harbour in the eighteenth century, having presumably been carried over from North America by clinging to the hull of a ship (Lankester, 1905, Q.J.M.S. 48, p. 229).

Mr. F. McNeil, of the Australian Museum, assures me that he knows of no records of king-crabs from Australian waters.

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# Discovery of the Breeding Habits of Leiopelma hochstetteri Fitzinger

By E. G. TURBOTT, Auckland Museum.

**Abstract.**

The discovery near Warkworth, in the North Auckland district, of eggs and intracapsular embryos of *Leiopelma hochstetteri* Fitzinger, 1861, is described, the development of this species proving to be of the direct type already known in *Leiopelma archeyi* Turbott, 1942. The eggs were found in holes beneath water-logged clay. The environment of adult and developmental stages of *Leiopelma hochstetteri* and *Leiopelma archeyi* is discussed briefly with reference to speciation.

Three species of New Zealand frog have been described, *Leiopelma hochstetteri* Fitzinger, 1861, *Leiopelma hamiltoni* McCulloch, 1919, and *Leiopelma archeyi* Turbott, 1942.

*Leiopelma archeyi,* the one species of which the life history is known, has been found only on the higher parts of the Coromandel Peninsula. The life history as found by Archey (1922)* is direct: the first stages are intracapsular, and the young frogs on hatching require no surface water to continue development, but move about freely on the damp earth and vegetation.

*Leiopelma hochstetteri* occurs in a number of localities in the northern part of the North Island, having been collected at Warkworth, Huia (Waitakere Hills), Te Araroa (East Cape), and on the Coromandel Peninsula. The breeding habits of *Leiopelma hochstetteri* have remained unknown, but throughout the range of this species the adults have been found commonly half submerged in water at the sides of forested streams.

In discussing the distribution of *Leiopelma hochstetteri* and *Leiopelma archeyi* at Coromandel (Turbott, 1942), I described *Leiopelma hochstetteri* as restricted to the immediate neighbourhood of surface water, *Leiopelma archeyi* occurring as was believed only on the adjacent hill tops. Later observations by Stephenson and Thomas (1945) have shown that the two species may occur in either type of habitat, adults of *Leiopelma hochstetteri* having been found on a high ridge at some distance from surface water in company with *Leiopelma archeyi,* and *Leiopelma archeyi* a few yards from stream beds inhabited by *Leiopelma hochstetteri.* Further, on 2nd January, 1949, I discovered a specimen of *Leiopelma archeyi* partly immersed in water at the side of a stream near the top of the main Coromandel divide at an altitude of c. 1,100 feet.

It is thus evident that an overlap in range, which I had not recognised, occurs at Coromandel between the two species. In this locality the high degree of atmospheric moisture and generally damp environment, evident characteristics of the Coromandel hill tops, may be regarded as factors essential to the well-being of both species in the absence of surface water.

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* Archey's material was of this species, which he did not distinguish from *Leiopelma hochstetteri.*

I am greatly indebted to Dr. N. G. Stephenson, Auckland University College, who has now completed a full study of the development of *Leiopelma archeyi,* for certain details of life history of this species which are later to be published.† The eggs of *Leiopelma archeyi* are commonly found at some distance from surface water, frequently under cover of stones or logs in apparently dry situations, but damp enough beneath to favour the direct type of development. In some cases Dr. Stephenson has found the eggs on a wet or water-logged substratum. Under experimental conditions corresponding to this, development proceeds normally, although the young frogs after hatching may be to some degree amphibious, that is they will wriggle about in water if the situation is sufficiently wet.

In the case of *Leiopelma hochstetteri,* from the commonly observed habit of the adults of remaining closely associated with water, it has seemed justifiable to expect that the life history would include an aquatic stage, although Stephenson and Thomas (1945), from their examination of the ovaries of specimens, have discounted the alternative (Turbott, 1942) that this species might have a tadpole comparable with that of *Ascaphus.*

The following notes record the discovery at Warkworth of eggs and characteristically intracapsular embryos of *Leiopelma hochstetteri,* which is thus found to have a direct development closely similar to that already known for *Leiopelma archeyi.*

New Zealand frogs, which proved to be *Leiopelma hochstetteri,* were discovered by Mr. S. G. Gittos on his property on the slopes below the prominent peak known as the Dome (1,105 feet), near Warkworth (Turbott, 1942). The finding of the eggs is due to the continued interest of Mr. Gittos, who communicated with me in the spring of 1948, saying that he had found egg capsules containing active embryos in the wet mud of a seepage or spring. These he had kept until the young frogs hatched out, but the specimens were not retained.

The habitat of *Leiopelma hochstetteri* is here an area of second-growth or regenerating forest bordering upon farmland. The altitude (550 feet) is lower than the hill tops and ridges at Coromandel inhabited together by *Leiopelma hochstetteri* and *Leiopelma archeyi,* although there is much similarity in topography and vegetation between the two areas.

Several streams descend from a forested ridge above the property, running at lower levels through grassland as open watercourses. On the steeper slopes above, the streams pass through ravines which contain forest, although the vegetation on the surrounding hillsides consists of rough pasture. Adult frogs have been found along all forested parts of these stream-beds which have been examined, and extend downstream into the open farmland where the banks support a sheltering scrub.

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† Stephenson, N. G. Observations on the Development of the Amphicoelous Frogs *Leiopelma* and *Ascaphus,* Journ. Linn. Soc. Lond. (in the press).

The eggs were first discovered last year by Mr. Gittos a few yards below such a forested ravine, and close to the neighbouring pasture land. Three groups of egg capsules were found in the wet mud of a seepage above the stream in the shelter of a large stone. There were three adult frogs under the stone; they did not appear to have been sitting over the eggs, although this habit has been observed in the case of *Leiopelma archeyi*.

On 16th November, 1949, in company with Mr. Gittos, I examined a more extensive seepage under the forest on the banks of another stream. This is in a hollow where the outcropping sandstone swings away some twenty yards from the stream-bed, although closing in to form steep, ravine-like banks above and below this point. The seepage is derived from a considerable flow of water which emerges along a bedding plane in the sandstones. The resulting swampy area is crossed at intervals by small but clearly-marked watercourses through which water would flow after rain. Numbers of adult and half-grown frogs were found in these drainage courses sheltering beneath stones which when lifted exposed a trickle of water.

Examination of crevices and tunnels in the extremely wet clay adjacent to the watercourses revealed more adult frogs, sitting in slowly percolating water. These holes and tunnels, in some cases descending vertically into the ground, were in most cases those of large dragonfly nymphs, and their course had been followed by the frogs a foot or more underground. It was in one such tunnel in water-logged clay that two groups of eggs were found, lying on the saturated floor of the tunnel, where they would undoubtedly be resting partly in water. As in the case described by Mr. Gittos, adult frogs were observed near the eggs, but were not sitting over them.

The two groups when found consisted respectively of ten and eleven eggs attached end to end to form a bead-like string: one group contained undeveloped eggs, but in the other the embryos were at an advanced stage and could be seen actively rotating within the capsules. Their stage of development at this time was approximately that of the 24-day old embryos of *Leiopelma archeyi* described by Archey. These notes, based upon my examination of the material when found, will be continued in detail by Dr. Stephenson, who has accepted the two groups of eggs for observation.

A search was made also in drier places along the stream above and below the seepage area, but without disclosing either eggs or adults.

It is particularly interesting that the eggs were in burrows of the highly predatory nymphs of a dragonfly (*Uropetala sp.*). Similar burrows made by *Uropetala* in peaty soil are described by Tillyard (1921). The burrows were common in the wet ground of the seepage, descending at least a foot underground as a system of branching tunnels. The nymphs were present in the wet mud in a number of burrows, some of which contained adult frogs, although there were apparently no nymphs near the branch tunnel containing the two groups of eggs.

With the discovery of the breeding habits of *Leiopelma hochstetteri* a brief assessment can be made of speciation problems. It is evident from Stephenson's results referred to above that the development of

*Leiopelma archeyi* proceeds in the same manner whatever the degree of moisture exhibited by the substratum. Dr. Stephenson's experimental work on the material of *Leiopelma hochstetteri* will probably demonstrate that the same is the case in this species. It is probable that the wider distribution of *Leiopelma hochstetteri* depends upon the habit of associating closely with surface water, and that it is thus possible for this species to live along the course of forested streams although in localities where there would be no high degree of atmospheric moisture to favour terrestrial habits as on the hill tops of Coromandel. The breeding habits of *Leiopelma hochstetteri* at Huia, Te Araroa, and in wet situations on Coromandel probably resemble those discovered at Warkworth, with similar requirements in respect to substratum; while on Coromandel the eggs would probably also develop in less wet situations similar to those of *Leiopelma archeyi.*

At the same time such an environment may be occupied, as Dr. Stephenson has shown, by *Leiopelma archeyi,* so that on the basis of these observations there would appear to be no barrier limiting this species to its present range. *Leiopelma archeyi* is generally found away from surface water on Coromandel, suggesting that its range may in fact be strictly limited by environmental factors as yet imperfectly known.

The two species, which Dr. N. G. Stephenson and Dr. E. M. Stephenson have found in the course of detailed study to be markedly distinct morphologically*, may be regarded as having diverged in geographical isolation, possible followed by the extinction of *Leiopelma archeyi* in most parts of its range. Invasion of the range of *Leiopelma archeyi* by *Leiopelma hochstetteri* could explain the overlap in distribution occurring so far as is known only on the Coromandel Peninsula. Further speculation as to origin would require more geological evidence than is at present available, and an interesting field is evidently open for more satisfactory ecological work on the two species. It may be suggested in conclusion that further exploration would probably extend the range of *Leiopelma hochstetteri* in the northern North Island.

Of *Leiopelma hamiltoni,* which may still exist on Stephen Island (Cook Strait), little is known and the life history has not yet been described.

Acknowledgment is made to the Hon. Minister of Internal Affairs for authorizing the taking of a limited amount of material for investigation.

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* Personal communication.

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# Observations on the Occurrence of the Weddell Seal in New Zealand

By E. G. TURBOTT, Auckland Museum.

**Abstract.**

Four occurrences of the Weddell seal in New Zealand are recorded, all in winter or early spring. A summary of these and several records from other localities is given, indicating that young animals in their first year have a marked tendency to appear as strays.

Bertram (1940) refers to a private communication in which R. A. Falla states that the Weddell seal, *Leptonychotes weddelli* (Lesson), is sometimes seen as a stray on the New Zealand coast. This seal is non-migratory and is rarely seen at any distance from the Antarctic coastline or on drifting ice, but strays have been recorded from the east coast of Patagonia in 1833, Juan Fernandez, Kerguelen and Heard Islands, and the Falkland Islands (Wilson, 1907; Bertram, 1940; Hamilton, 1945), and from Encounter Bay, South Australia (Wood Jones, 1925).

This note records four occurrences in New Zealand, including that of a specimen recently found ashore on Muriwai Beach, near Auckland.

Hector's identification (1893) of a seal from outside Wanganui Heads in the Wanganui Public Museum as *Leptonychotes weddelli* is referred to in most accounts of the Weddell seal, but Oliver (1921) found this specimen to be a crabeater, *Lobodon carcinophagus* (Jacquinot and Pucheran). Hector's record is given by Bertram (1940) in a quotation from Wilson's National Antarctic Expedition report (1907).

There is a correctly determined mounted skin of this species, with the skull included, in the Dominion Museum, Wellington. This seal, a male, was collected on 26th June, 1926, in Titahi Bay, on the west coast eleven miles north of Wellington. I am grateful to Dr. R. A. Falla, Director of the Dominion Museum, for permission to record the specimen.

Dr. Oliver has kindly given me the following notes taken on this specimen in the flesh: teeth $\frac{2}{2}\ \frac{1}{1}\ \frac{5}{5}$ ; colour, above brown with longitudinal spots of buff, the brown on the sides behind the flippers darker; below buff with irregular markings of light brown; head brown above, buff below, the neck buff mottled with brown. Total length, including the hind flippers, 60 inches (153 cm.).

The total length of the mounted specimen, measured from snout to tip of tail, is 52 inches (132 cm.).

Dr. Oliver has also supplied information about a Weddell seal which came into Wellington Harbour on 29th June, 1937. This animal, which had been injured, probably by a shark or killer whale, was approximately six feet long, and as shown by a photograph which I have examined was

in particularly good condition. It was seen again at Napier four days later, both Wellington and Napier visits being described in press accounts in the Wellington "Dominion" of 30th June and 6th July, 1937.

I am indebted to Mr. C. A. Fleming for a third record of a Weddell seal, which was seen ashore on Enderby Island, the northernmost member of the Auckland group, on 26th September, 1942. Mr. Fleming has a photograph of this seal, which from some distance appeared to be approximately seven feet in length.

The fourth record is that of a seal found on the ocean beach at Muriwai, twenty miles west of Auckland, by Messrs. R. M. Cassie and A. H. Taylor, of the Marine Department, and D. and G. McKenzie, on 4th August, 1948. It had been injured by a rifle shot and died four days later at the Auckland Zoological Park.

This specimen, now mounted in the Auckland Museum collection (MAMM. 43.1), is a young male. The coat is dark grey above, paler grey with white mottling on the sides and yellowish white below; the tail has a well marked white border. Total length from snout to tip of tail, measured in the flesh: 68 inches (173 cm.).

The following bones have been preserved separately: skull (Plate 69), total length (occipital condyle to tip of premaxillae), 234 mm.; maximum zygomatic width (outside), 143 mm. Os penis, length 83.5 mm.

The pupping season of the Weddell seal in the Ross Sea is at its height in the third week of October, all the young being born within a period of four to five weeks (Bertram, 1940). By August, young born the previous year would thus be between nine and ten months old. The body and skull measurements of the Auckland Museum specimen fall within the range of nine-ten months old Weddell seals given by Bertram. According to body length, the three remaining seals would also be young still in their first year, although the lengths are only estimates in the case of the two field records.

It may be noted that the skeleton from Betsy Cove, Kerguelen, described in detail by Turner (1888) is that of a young seal, believed to be a female, shot on 9th January, 1874. Although probably some months older, this specimen proves to have been almost identical in size with the Muriwai specimen, the measurements given by Turner being: skull length 237 mm.; interzygomatic width 142 mm. Bertram's measurements of material from Graham Land show that young seals of different age groups may vary markedly in size. In addition, it may be possible that the seal from Kerguelen had come from a later-breeding colony than the Auckland specimen.

The specimen from Encounter Bay referred to by Wood Jones (1925) is displayed in the South Australian Museum, Adelaide. I am indebted to Mr. H. M. Hale for the information that this is a young male seal, five feet in total length, taken on 17th April, 1913.

Gray (1866) lists the two specimens in the British Museum from the River Santa Cruz, on the east coast of Patagonia, as adults. Hamilton's record from the Falkland Islands (1945) is that of a Wed-

dell seal about six feet long observed on 28th October, 1943. The estimated length suggests that this also was a young animal under one year old.

Interest is attached to young Weddell seals as strays, for according to Bertram very little is seen of the young after they take to the water until they reach breeding age, in the case of the females during their third year. It is presumed that the young seals spend most of their time in the water feeding, but there is also some suggestion in the records from several localities given above that they have a greater tendency than the adults to move away from coastal waters.

It is noteworthy also that the New Zealand occurrences have all been in winter or early spring, as might be expected if the seals had strayed northwards in summer, possibly drifting on ice which would break up in autumn.

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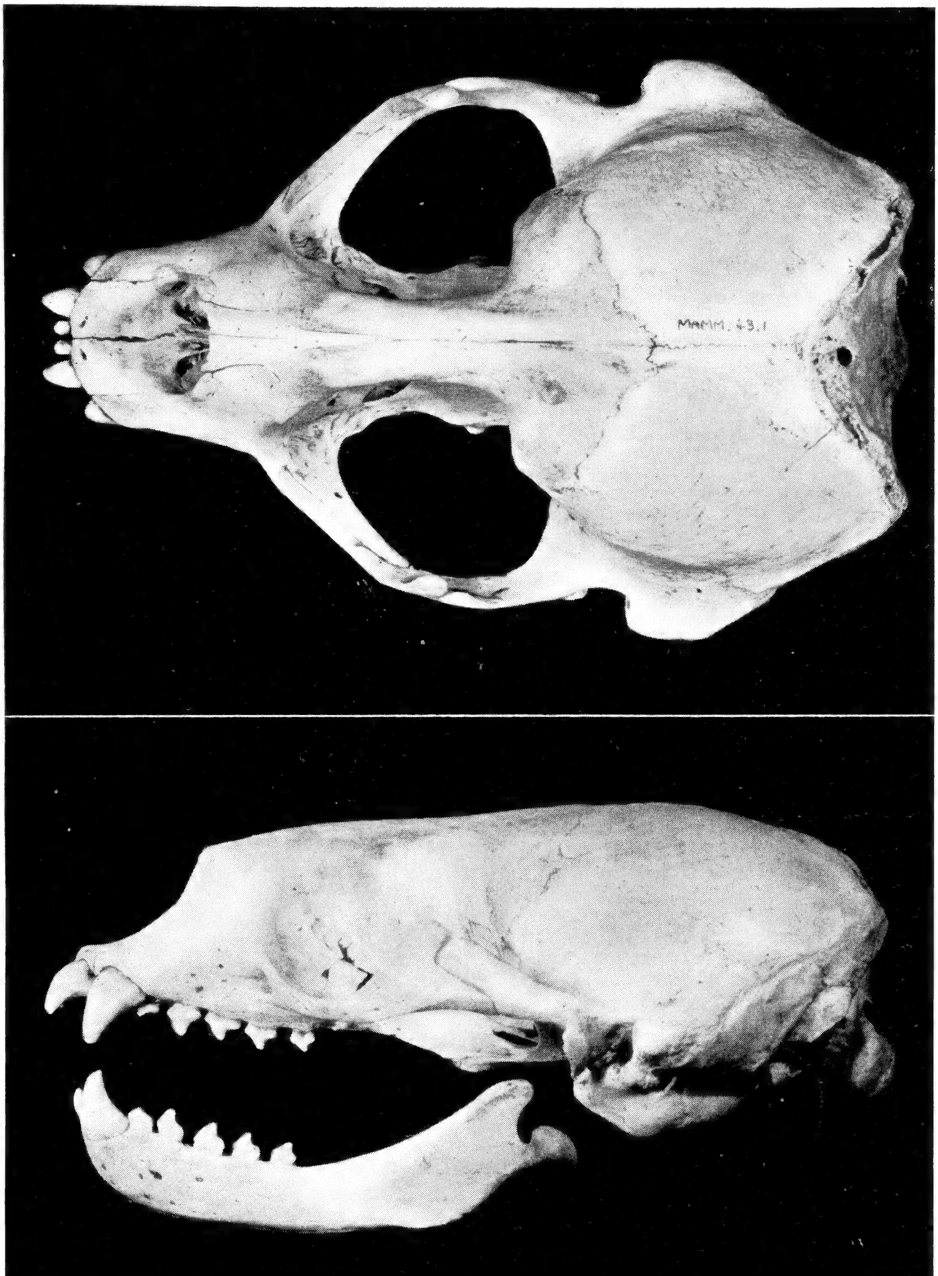



Skull of Weddell seal (Auckland Museum 43.1) from Muriwai Beach; (above) dorsal and (below) lateral views.

# The Effect of the recent Eruption on the Plants of Ngauruhoe

By ROBERT COOPER, Botanist.

**Abstract.**

The effect on the vegetation of hot lava and ash associated with the recent eruption of Ngauruhoe, and a description of the plant community in the vicinity of the new deposits. A rare opportunity is presented for subsequent recording of plant colonization of virgin ground.

1. *The Eruption:* Ngauruhoe, 7,500 feet high (2286 m.), is the central peak in a short chain which has shown intermittent volcanic activity for many years. The recent eruption began on 9th February, 1949, with the discharge of rocks from the crater. Lava emerged on the following day, and streamed down the north-west slope of the cone into the Mangatepopo Valley. The eruption of ash clouds followed the lava phase, and continued until all activity ceased about the end of February. Two bare areas resulted from the eruption. The larger area is the lava flow, about 6,000 feet long (1829 m.) and 180 to 420 feet wide (55 to 128 m.). It descends from 7,500 feet (2286 m.) to 4,700 feet (1432 m.). The second area is the debris fan at about 4,550 feet (1386 m) above sea level. It is situated below the new lava flow, on the old lavas in the Mangatepopo Valley, and is at least 450 feet (137 m.) long by 360 feet (110 m.) wide, but the boundaries of it are not clearly defined.

Cockayne (1908) has outlined generally the sequence of events in the development of a plant covering on the Volcanic Plateau, and the recent eruption has presented an opportunity to study the process on a new lava flow and a debris fan. It is known that volcanic deposits are very sterile and that the development of vegetation on them is relatively slow, but the new deposits are small in area and readily accessible to plant migrants.

It may be many years before there is anything to record, but there is little information on the subject and the opportunity to observe the colonization of an area of virgin ground, under natural conditions, is too rare to be missed. Aston (1916) and Turner (1928) have described the new vegetation of the mud and ash deposits of Tarawera, and Oliver (1942) has recorded the colonization of the Napier harbour bed raised by the 1931 earthquake.

The aim of this paper is to describe the present plant community in the vicinity of the new deposits, and to record the effect of the hot lava and ash on the vegetation.

2. *The Habitat:* Allan (1926) has described the variety of habitats or growing places provided by rocks, and pointed out the need for detailed records with instruments. At this stage of the study, however,

only a general account of the climatic factors is possible. Cockayne (1908) had little meteorological data, but remarked that the volcanic plateau lies across the path of cyclonic depressions and has a much more abundant rainfall on the tree-clad south and west than on its eastern side. Weather records have been kept in recent years at the Chateau Tongariro, 3,670 feet (1183 m.) above sea level, and some six miles (9.6 km.) south of the new lava flow and debris fan.

The mean annual rainfall is 106 inches (269 cm.). The number of days with rain each year averages 186, and the mean monthly rainfall ranges from 6.91 inches (17.55 cm.) in February to 10.77 inches (27.35 cm.) in October. The range in mean monthly temperatures is from 35.5° F. (1.9° C.) in July to 53.1° F. (11.7° C.) in February. The absolute minimum for the 12 months ended July, 1949 was 21° F. (− 6° C.) and the absolute maximum was 79° F. (26° C.). The director of Meteorological Services, Air Department, Wellington, has supplied the following table, from which most of the figures quoted above are taken.

CHATEAU TONGARIRO.

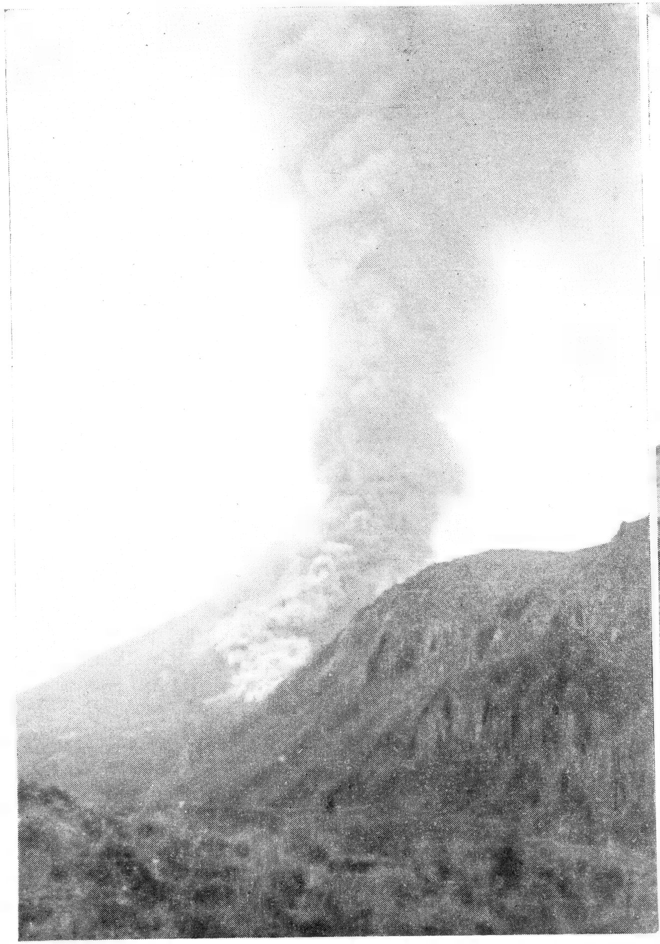
Lat. 39°12′S; Long. 175°32′E. Alt. 3,670ft.

| | 1 Jan. | 2 Feb. | 3 Mar. | 4 Apl. | 5 May | 6 June | 7 July | 8 Aug. | 9 Sep. | 10 Oct. | 11 Nov. | 12 Dec. | Yr. or Mean |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Rainfall (in.): | 8.41 | 6.91 | 6.94 | 8.92 | 7.96 | 10.38 | 9.08 | 8.40 | 10.55 | 10.77 | 9.02 | 8.89 | 106.23 |
| Raindays: | 16 | 14 | 13 | 15 | 16 | 15 | 15 | 17 | 16 | 17 | 15 | 17 | 186 |
| Approx. Mean Tem. (°F.) = ½ (Max. + Min.) | 52.4 | 53.1 | 50.6 | 46.2 | 40.6 | 36.7 | 35.5 | 37.1 | 38.8 | 42.5 | 46.4 | 49.2 | 44.1 |

Temperatures change rapidly with clouding, and night frosts are common at all seasons. Small patches of snow remain all the year on the upper slopes of Ngauruhoe and the cone is covered in the winter and spring. The main falls are in June, July and August, but falls have been recorded in all seasons.

The Director of Meteorological Services has advised that wind records at the Chateau are based on non-instrumental observations and that he is unable to supply detailed wind statistics. A wind rose for the years 1939 to 1944 has been prepared from the published observations, taken at 9 a.m. each day, and it shows that approximately 50% of the winds blow from between the north-west and south-west.

The soil factor, and the important effect it has on the vegetation, has been described by Cockayne (1908, p. 23). The north-west slope of Ngauruhoe, about the new lava flow and debris fan, is dissected by shallow dry ravines. The ridges between the ravines are old lava flows, and the soil is restricted to crevices and hollows. In the summer months, the limited soil or humus covering, and the rapid drainage on the steep slopes, result in drought conditions, although the area is subject to a heavy and regular rainfall.



A hot avalanche of the morning of February 9, photographed from Mangatepopo Hut.
Photo. by courtesy of Mr. R. H. Bates, Wanganui.

The lava flow at mid-day on February 11.
Photo: M. H. Battey.

3. *The Vegetation:* Cockayne (1908) listed 38 ferns and 222 seed-plants in the Tongariro National Park. At least 45 are to be found in the Mangatepopo Valley, forming a dense cover in the Mangatepopo Gorge and in sheltered hollows among old, weathered lava flows. On the north-west slope of Ngauruhoe above the valley floor the plants become fewer, and at 6,000 feet (1829 m.) the slopes are barren. At 4,700 feet (1432 m.), on the slopes about the new lava flow and debris fan, six one-metre permanent quadrats were painted on the rocks, a 30-metre bisect was dug, and 35 one-metre quadrats were selected at random an listed. Only 10 species of plants were found, but a rapid examination of the slopes indicated that this is the total number present in the immediate vicinity of the flow and debris fan. All of the species are members of the richer flora of the Mangatepopo Valley. The species list is given below. The frequency, on the usual 1-5 notation, is shown on the left-hand side of the list. The area of each quadrat occupied by plants has been estimated and the total cover of vegetation works out at 9% of the area studied. The cover of each species has been worked out and is expressed as a percentage of the total cover. The percentages are shown on the right-hand side of the species list.

CHATEAU TONGARIRO.

| Frequency. | Name of Species. | Percentage of total cover. |
|---|---|---|
| 4 | *Danthonia setifolia* (Hook. f.) Ckn. | 18% |
| 3 | *Dracophyllum recurvum* Hook. f. | 47% |
| 1 | *Anisotome aromatica* Hook. f. | 1% |
| 1 | *Gaultheria colensoi* Hook. f. | 4% |
| 1 | *Helichrysum bellidioides* (Forst. f.) Willd. | 1% |
| 1 | *Raoulia australis* Hook. f. ex Raoul | 1% |
| 2 | *Stereocaulon denudatum* Flk. (lichen) | 25% |
| 2 | *Rhacomitrium crispulum* (H. f. & W.) H. f. & W.<br>*R. lanuginosum* (Hedw.) Brid. var. *pruinosum* H. f. & W.<br>*Campylopus clavatus* (R. Br.) H. f. & W. | (mosses) 3% |

Dried specimens of each species have been placed in the Cheeseman Herbarium at the Auckland Museum.

The area studied may not be large enough to give a true picture of the frequency and cover of each species, but the time available for the work was limited.

Although *Danthonia* was found in more quadrats than *Dracophyllum,* the latter covers a larger area and its red foliage gives the community a characteristic appearance. The small area occupied by lichens is surprising, but possibly the occasional deposits of ash are responsible for their scarcity.

The total area figure shows the open character of the community. There are plenty of suitable places for colonization which are not occupied, and the contrast between the community and the closed vegetation of the lower Mangatepopo Valley is most marked. Geologically, the

terrain becomes younger as the Mangatepopo Valley is ascended, and Cockayne (1908, p. 25) states that the open community is merely an early phase in the development of vegetation. A record of changes in the area figures of the permanent quadrats may throw light on the development phases.

The habit of *Dracophyllum recurvum* and *Danthonia setifolia* have been described by Cockayne (1908) and the chief adaptation features are stated to be great length of root and closeness to the ground. All the seed plants are perennials with marked xeromorphic features. The bisect showed that *Dracophyllum* develops roots on buried branches, an adaptation which may enable the plant to survive burial in ash. The bisect also showed that the main roots of the seed plants are in the top 8 inches (20 cm.) of soil. Although the community is an open one, competition between the roots of *Danthonia* and the other seed plants was found in six pockets of vegetation traversed by the bisect.

4. *The Effect of the Eruption on the Land Surface and the Vegetation:* The location and area of the lava flow and debris fan have been described, and Battey is preparing a map for publication. The lava flow consists of blocky andesite, the surface of which is still somewhat unstable. The debris fan is composed of large blocks of rock embedded in sand. The rock came from avalanches at the beginning of the eruption and from lava masses which rolled down from the flow. The sand is probably derived from the early avalanches, and the ash showers which concluded the eruption. Both the lava flow and the debris fan had warm areas in May.

The rock avalanches, and the lava blocks which broke away from the flow, cut a smooth-sided ravine down the north-west slope of the cone and the lava flow advanced down this channel. The vegetation in the path of the flow was destroyed, but it is possible that buried parts of plants have survived in the debris fan. The whole of the north-west slope of the cone was disturbed by falling debris during the eruption, and subsequent erosion has exposed the roots of plants in many places.

The hot ash showers affected the species as follows:

*Danthonia*—leaf tips charred but the tuft or clump had not disintegrated.

*Dracophyllum*—apparently unaffected.

*Anisotome*—leaves shed and new leaves developing.

*Gaultheria*—leaves charred and shed. Plants appeared dead.

*Helichrysum*—dried or charred to soil surface but new shoots developing.

*Raoulia*—dried and apparently dead.

*Lichen*—charred.

*Mosses*—charred.

This summary was made on the 18th May. The plants are strongly xeromorphic and, although a number appeared to be dead in May, it is probably that most of them have survived and will produce new shoots when the snow melts in the coming summer.

The hot rocks which reached the floor of the Mangatepopo Valley started a number of fires in the vegetation, but the areas burnt were not large.

The quantity of dust and sand stirred up by the falling stones, produced by the movement of the lava, and erupted during the ash phase, was considerable. A surface layer, varying in depth from several inches to several feet, covered the lower north-west slope of the cone on the 11th February, before the main ash clouds were produced. Much of it had blown or washed into crevices when the mountain was visited last May, and no doubt pockets of it formed in the new lava flow. The slow production of a soil by weathering, and the decay of lichens and mosses, has been described as the first phase in the colonization of bare rock (Cockayne, 1908, p. 26, and 1928, p. 107—note on Rangitoto), but there is some evidence that a soil is present in the crevices of the new lava flow and it is possible that the lichen-moss stage will not be necessary before seed plants migrate to it.

In conclusion, I wish to thank the Director of Meteorological Services, Air Department, Wellington, for supplying statistics of rainfall and temperature, and for granting permission to publish same; Mr. G. O. K. Sainsbury, of Wairoa, for the identification of three mosses; Professor V. J. Chapman, of Auckland University College, for advice regarding this paper; and Mr. M. H. Battey and Miss M. Hurrey, of the Museum staff, for assistance in the field.

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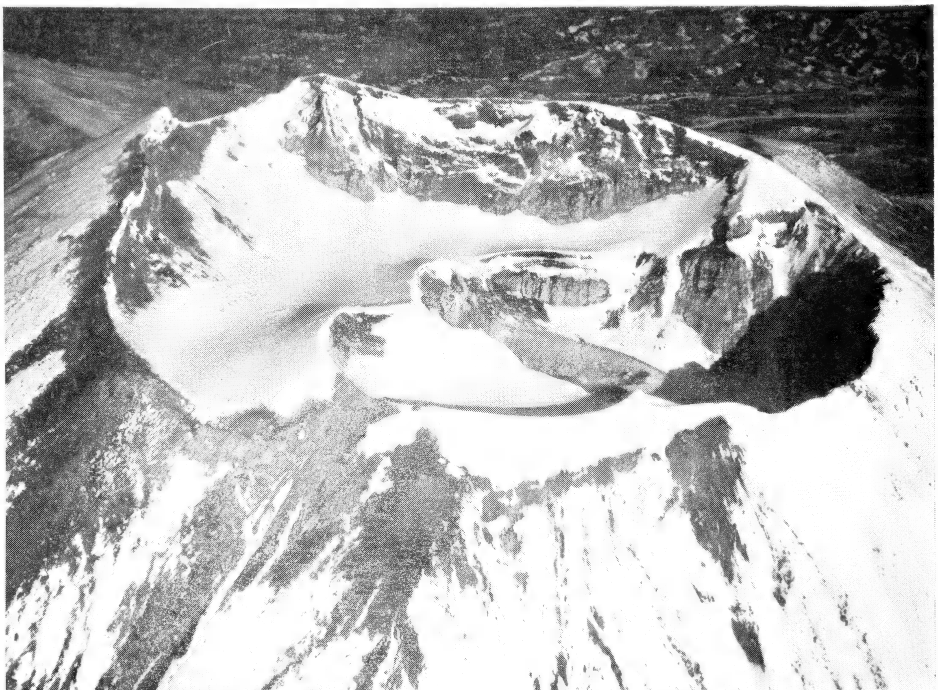


Fig. 1. Ngauruhoe crater from the north in 1934, showing the north-north-west sub-crater (in front) and the west sub-crater in which is a small nested cone.

Photo: Whites Aviation Ltd.

Fig. 2. The crater from the west in the late afternoon of February 9, showing the gently-domed tholoid.

Photo. by courtesy of Mr. S. J. Blackmore, Air Services Ltd., Rotorua.

# The Recent Eruption of Ngauruhoe

By M. H. BATTEY, Geologist.

## Abstract.

An eruption of the andesite volcano Ngauruhoe took place during February, 1949. A number of hot avalanches were discharged in the early stages; this phase was succeeded by the emission of a lava flow 2,000 yards long, and the eruption concluded with a period of explosive ash-production such as has formed the only manifestation of activity previously observed.

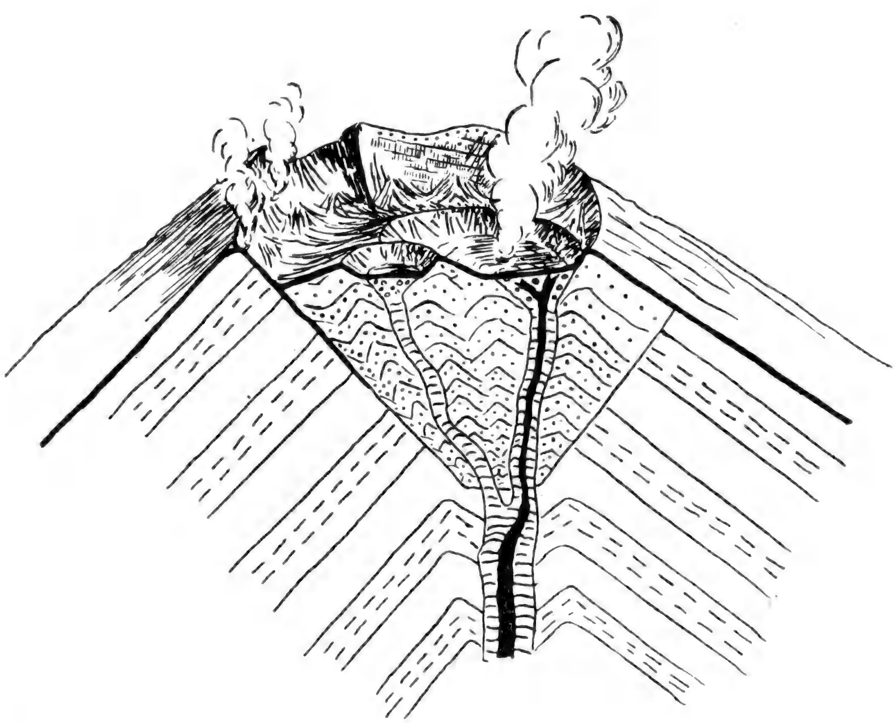
This paper describes the early part of the eruption and, in particular, the phenomena connected with the lava flow, which was the first to be observed in New Zealand. A map of the flow is presented and the petrography of the lava is briefly discussed.

*Introduction.* Ngauruhoe is a symmetrical volcanic cone built to a height of 7,500 feet upon the southern flank of the older complex volcano Tongariro (6,458ft.), which rises, alongside the volcano Ruapehu (9,175ft.), above the central plateau of the North Island of New Zealand.

Ngauruhoe has shown intermittent activity, with the emission of clouds of ash, ever since it has been under observation. Bidwell (1841), the first European to climb the mountain, made his ascent during a phase of mild explosive activity in 1839. Thomson (1926, pp. 358-9) has given a summary of the recorded activity up to 1926; since then the volcano has been reported active some half-dozen times, the latest manifestation, prior to the eruption of February, 1949, being a vigorous explosive outburst in the first week of May, 1948.

It would seem that there has been little fundamental change in the crater of Ngauruhoe, at least since the year 1887. The main crater is a roughly circular depression somewhat more than a quarter of a mile across, bordered on the south and east by steep cliffs which are probably rather more than 300 feet high at their highest point, on the south-east. On the north and west the rim is very much lower, and at its lowest point it rises but little above the level of the general crater floor (cf. sketches by Hill, 1891a, Marshall, 1908, and plate 71, fig. 1, accompanying this paper). Within this crater, towards its western lip, two centres of activity have apparently persisted for many years. Hill (1891a, pl. XLV) in his sketch of the crater in 1890 depicts these two sub-craters and remarks (p. 611) that they were clearly defined and quite separate, while Cussen (1891) shows two sub-craters, likewise, on his map. Marshall (1908, p. 103), while agreeing with Hill's description (in which two sub-craters are mentioned), asserts positively that the more southerly of Cussen's two sub-craters was not there in January, 1891. In 1893, however, according to Marshall, an explosion crater had appeared in the central part of the main crater, more or less in the position of Cussen's southern sub-crater, and it subsequently became enlarged until, by 1906, its west wall was coincident with that of the main crater. From this time forward the two sub-craters have persisted, one in the north-north-west and the other in the western part of the main crater. Minor

changes, such as the building of small cones about the vents and the partial filling and coring out of these sub-craters, have taken place from time to time. Fumaroles are marked at the foot of the high cliffs on the north-east side of the main crater on Turner's map (1911), while Hill (1891a, p. 611) records the issue of steam from the walls of the major crater over most of the face exposed. (A trace of steam can be seen above the N.E. cliffs in plate 73, fig. 2.) Fumaroles have also long existed on the north-north-western exterior slopes of the cone. Hill, 1891, pp. 60-2, mentions them, and Turner (1908) estimates that they are roughly 150 feet below the crater rim. The activity at these places, so far from the main vent, when taken in conjunction with the fact, first noted by Hill (1891b), that "on the sides of the cone where the lip of the crater is lowest there is hardly any trace of lava; ashes, cinders and scoria prevail . . ." suggests that at some time the north-west part of the summit of Ngauruhoe has been destroyed by explosion or collapse, and that a secondary cone has been built up within the resulting depression, about the historic centre of activity (see Text fig. 1). The north-west slopes of this secondary cone are confluent with those of the main volcano, the junction of old and new structures affording a path to the surface for some of the volcanic exhalations, so that its surface trace is marked by the fumaroles on the outer slopes of the cone and below the north-eastern cliffs of the main crater rim.



Text fig. 1. Suggested structure of the upper part of Ngauruhoe cone.

Red hot lava was reported in the western sub-crater in January, 1911 (Turner, 1911, p. 35; Marshall, 1934, p. 4), and again in March, 1928 (Grange, 1928, p. 146), and fairly vigorous explosive activity took place on the second occasion.

The lava-front at 9 a.m. on February 12. The flow stopped just before reaching the flat. The edge of the avalanche debris-fan appears in the right foreground.

Photo: M. H. Battey.

The steep front of the advancing flow on February 11 was about 20ft. high.

Photo: R. C. Cooper.

It has been asserted that a lava-flow was extruded from the crater in 1869 or 1870 (Hector, 1887, pp. 463-4). The facts are uncertain, but two lava-flows certainly of very recent date extend to the foot of the cone on its north-north-west flank (Hill, 1891b, p. 165), while another has spread out towards the floor of the South Crater of Tongariro, at the northern base of Ngauruhoe cone (Thomas, 1888, p. 341; Grange, 1928, fig. 1). Hill (1891a, p. 609) maintains that the one that he describes was noted by Bidwill in 1939, and (p. 612) that no lava was erupted in 1869.

*The Eruption of 1949.* Quite abruptly, at about 1.30 a.m. on Wednesday, February 9, 1949, Ngauruhoe began a new phase of violent activity.

On the previous day two climbers, Messrs. R. H. Bates and T. P. Baker, had ascended the mountain to a height of 6,500 feet before cloud forced them to return, and during this climb they apparently noticed no premonitory signs of the activity that ensued.* When the eruption began, these two observers were in Mangatepopo Hut, which stands a little more than two miles in a direct line from the crater, opposite and 2,300 feet below the lowest point of its rim.

The eruption did not begin very noisily; some crackling sounds were heard at 1.30 a.m., but it was not until 2.30 a.m. that it was realised that the mountain was in eruption, at which time a red glow could be seen at the summit and boulders were bounding down the slopes. After 9.30 a.m. a clear view of the volcano was obtained and a series of what appear to have been hot avalances was seen to descend the slopes of the cone below the lowest part of the main crater rim. Mr. Bates took a photograph (which he has kindly permitted me to reproduce as Plate 70, fig. 1) of one of these awe-inspiring discharges as it plunged down the slope of the volcano.

The fact that the avalanche material came to rest immediately at the foot of the cone shows that its main propulsive force was gravity rather than explosion of the avalanche particles themselves, so that it must be classed as a glowing avalanche in the usage of Williams (1941, p. 380), rather than as a *nuée ardente*.

Later investigation showed that hot sand and blocks of lava, presumably from such avalanches, covered a sector which was estimated at 350 yards across, on older blocky lavas at the north-west base of Ngauruhoe cone, but the most considerable accumulation was a debris fan about 38,000 square yards in area on the lavas of the floor of Mangatepopo Valley directly below the tip of the later lava-flow. Very large blocks of hot lava were embedded in the sand, and probably many of them formed part of the avalanches; before the products of these avalanches were seen, however, many lava masses tumbling forward from the advancing flow must have added to the original heap of debris, for this process was going on actively when the area was first visited. Subsequently some of the large blocks on the fan spalled down into small pieces as they cooled, but many remain.

* This account is condensed from that written at the time by Messrs. Bates and Baker in the Mangatepopo Hut Visitors' Book. Mr. J. Healy, of the N.Z. Geological Survey, has, however, kindly allowed me to see a later report by Mr. Bates, wherein it is recorded that faint mutterings, as of distant thunder, were briefly heard during this ascent.

This fan-shaped mass of sand and lava blocks below the tip of the lava-flow retained its heat for a considerable time. Small "rootless" fumaroles were still steaming and actively depositing sulphur late in April, while in the middle of May at an air temperature of 54° F. a thermometer laid on the sand registered 92° F., while at a depth of three inches the temperature was 122° F.

After 1 p.m. on February 9 the volcano was not under close observation until between 6.00 and 7.00 p.m., when Mr. S. J. Blackmore, of Rotorua, circled over the mountain in an aircraft and took an excellent series of photographs of the crater. These photographs reveal that, at this time, the western sub-crater was filled to within a few tens of feet of its western (outer) lip by a tholoid or plug of lava, the surface of which was gently domed (plate 71, fig. 2). The emission of volcanic gases was taking place very largely from a single vent in the eastern part of the tholoid, more or less above the site of a conelet that had existed in the western sub-crater for a number of years prior to the recent activity (see for example Cotton, 1944, fig. 111, p. 227), while the north-north-west crater was quite inactive. The tholoid seems to have been quite similar to that which rose in the crater of Ruapehu during 1945 (Reed, 1946, Oliver, 1946, Cotton, 1946), and which was examined at close quarters by Oliver.

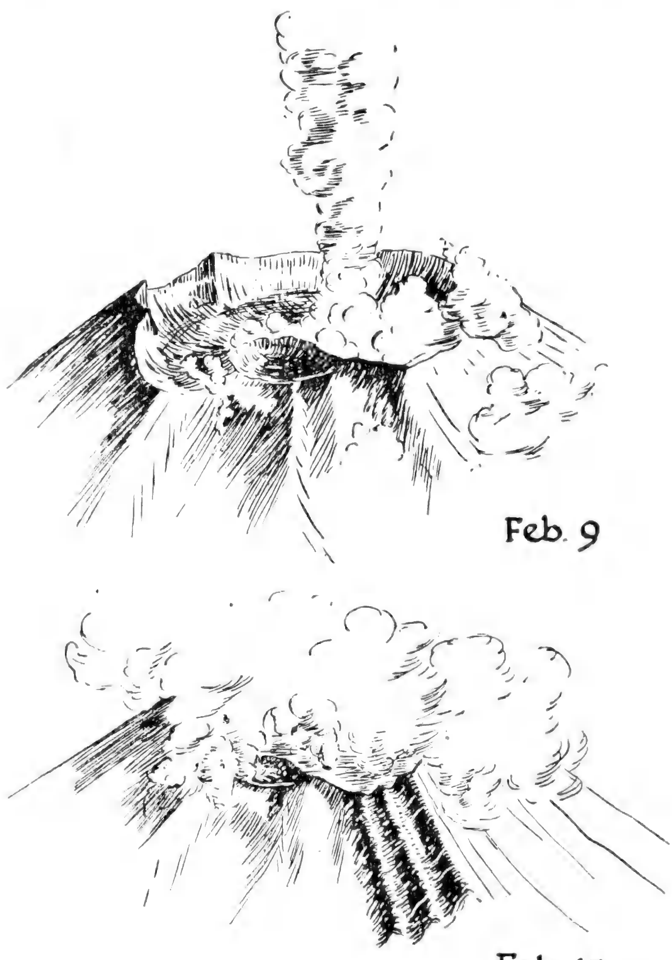
Some time between 7 p.m. on February 9 and midnight on Thursday, February 10 the rising lava spilled over the north-west lip of the crater and began to descend the side of the cone as a blocky lava-flow. During almost the whole of Thursday the volcano was obscured by cloud, but by midnight the lava-flow was brilliantly visible from a point some 20 miles north-west of the mountain, and already extended well down its flank. It is, of course, difficult to judge, but possibly the lava had by then reached the foot of the ash-cone proper. At this point the flow changed its direction of advance from N.W. by W. to a little N. of N.W., and by noon on Friday, February 11, the lava front had moved forward a quarter of a mile from this bend, over a sloping shelf of older lavas fringing the north-west base of the cone. During this period of 12 hours the lava had advanced probably 600 yards, an average rate of 50 yards an hour. The average slope over this part of its path is about 1 in $2\frac{1}{4}$, but the initial deflection of the flow took place by a side-slip on a much steeper grade. Between 3 p.m. on February 11 and 9 a.m. on the 12th it advanced only about 200 or 250 yards and not many hours later movement ceased, the flow having attained a length of nearly 2,000 yards along the slope, with variation from 50yds. to 150yds. in width, and having a volume of the order of $\frac{3}{4}$ million cubic yards (see map, plate 74).

The flow progressed by the crumbling forward of the steep terminal face under the pressure of rock behind, to the accompaniment of a continual clattering noise. By the afternoon of Friday the blocks that formed the surface of the flow were black, bright red lava showing only in the chinks, but sometimes white-hot rock was disclosed by the tumbling forward of large masses of rock from the terminal face. These rolling rock masses gouged out a channel in the poorly consolidated materials in front of the flow and played a part in defining the course which it subsequently followed. The andesitic lava was quite rigid under the hammer at dull red heat, and the brittleness of the hot blocks in general was a striking characteristic.

Fig. 1. General view of the lava flow with the fan of avalanche debris below its tip.
Photo: M. H. Battey.

Fig. 2. Air-view of the crater in early March, at the end of the eruption.
Photo: Photo News Ltd.

Levees or "moraines" of piled up lava blocks, such as are commonly formed at the margins of blocky flows, were well developed along the whole length of the flow. In addition, there was a conspicuous median dark zone which appeared to stand as a ridge above the general surface of the flow. As can be seen from plate 70, fig. 2, rolling blocks on the flow were guided down the two gutters between this median ridge and the marginal levees. (It may be mentioned that this dark central zone was visible from a distance of 20 miles on the night of February 10-11, when the main part of the flow glowed much more brightly than on the succeeding night, and must have been moving very actively.) The marginal levees are readily explained as the result of stranding of cooled blocks along the edges of the lava stream, but the reason for the presence of the median ridge is not obvious. Perhaps the flow broke through the crater rim in two places and actually descended the cone as a twin stream, the ridge in the centre representing the junction between these two lines of flow. As may be seen in plate 70, fig 2, the median ridge extended up to the very lip of the crater, while a photograph taken by




Text fig. 2. The north-west crater rim before and after the emergence of the lava flow. Drawn from photographs by Mr. S. J. Blackmore, Rotorua.

Mr. Blackmore on February 13 shows that the lava flow crosses the crater lip in two trough-like passes, with the uppermost end of the median ridge standing between them where, before the emission of lava, there was a slight rise in the middle of the low portion of the crater rim. If the original outbreak occurred in two places the two separate, though contiguous, lava-tongues would be likely to persist as a result of the channelling action, mentioned above, of boulders from each tongue. During the cooling of the flow the lava blocks spalled into small fragments, and by May the median ridge, and the whole upper part of the flow, was becoming ill-defined (plate 73, fig. 1.).

A comparison of two of Mr. Blackmore's photographs taken on February 9 and February 13 from more or less the same position discloses that the lip of the crater was lowered considerably by collapse under the pressure of lava at the time when outflow occurred (see Text fig. 2). This breaking down of the outer crater rim has always seemed a necessary postulate in envisaging the escape of the lava on to the external slopes of the cone, since the testimony of all observers in recent years is that, before the eruption, the eastern rim of the active sub-crater was somewhat lower than that on the west where the escape of lava actually took place. There is nothing to suggest, however, that the avalanches witnessed by Messrs. Bates and Baker on the morning of February 9 were part of this process. Mr. Blackmore's photographs taken on the evening of that day indicate that collapse had not then begun, while most of the material deposited by the avalanches gave every evidence of being of juvenile origin.

During the "lava phase" of the eruption (the phases that Cotton (1946) distinguished at Ruapehu are apt to the present case) very little ash was emitted. The explosions in the vent ejected mainly coarse pyroclastic material. Blackmore's photographs suggest by the light colour of the eruptive cloud that this was also the case during the growth of the tholoid. On February 11 the gas cloud was quite white, having merely a faint yellowish tinge in comparison with ordinary cumulus clouds (see plate 70, fig. 2). A gigantic steady panting sound testified to more or less continuous gas emission at this time. Occasional lulls of three or four minutes' duration indicated temporary blockage of the vent which was relieved by a heavier explosion, sometimes sharp and sometimes deep-toned, followed by a resumption of the rhythmical discharge of gases. Although showers of large hot blocks were being ejected from the crater, the production of ash was quite subordinate.

The lava phase was succeeded, as at Ruapehu, by an ash phase, during which voluminous and spectacular ash-clouds were erupted by intermittent explosion. This form of activity continued with diminishing intensity until the end of February, when the eruption may be said to have ceased.

The tholoid and the lava flow derived from it may perhaps have represented a relatively cool magma-product forced up by gas-pressure developed in the magma below, capable of a limited amount of flow, but too viscous to be shattered by gas-pressure due to expulsion of its own volatiles (cf. Cotton, 1944, Ch. XI, etc.). After the outflow of lava, hotter, less viscous material below exploded under reduced pressure and gave rise to the ash phase.

Photographs (for example plate 73, fig. 2) taken from the air in the early days of March, disclosed that the fragmental material of this last phase had filled up the active sub-crater and the eastern part of the main crater, so that the area enclosed by the main crater rim appeared more or less level. There remained, however, a steep slope on the north side of the active sub-crater, between it and the north-north-west sub-crater, while the latter, though still quite distinct, had been partly filled with rubble. The same state of affairs was found to exist when the crater was visited on May 18. The rubble in the active sub-crater was steaming in places, but the chief source of steam was the steep face on the northern side of the sub-crater. The north-north-west sub-crater was now only about 25 feet deep (it was 90 feet deep in 1928, when Grange and Hurst mapped it) and was quite inactive. An actively-steaming fissure could be traced along the rim of the steep north side of the active sub-crater, and Mr. C. Christophers, who climbed the volcano on the following day under better weather conditions, tells me that similarly active fissures margined the active sub-crater on the east and south sides also. The high cliffs on the north-east side of the main crater rim were also steaming strongly on May 18. Since then, there have been occasional reports of small steam clouds above the volcano, while visitors to the mountain have noted a certain amount of rubble on the fresh snow near the summit, indicating that there have been mild explosions. It seems likely that by this means, and perhaps also by the breaking away of its walls along the encircling fissures, the rubble-choked west sub-crater will gradually be deepened for a time, as it resumes the course of minor variations in aspect which have have gone on since the later part of last century.

## Petrography of the 1949 lava

Thomas (1887, p. 308) described as augite-andesites a number of rocks collected at Ngauruhoe by Cussen, including one from the supposed 1869 lava flow. The presence of hypersthene is not recorded. He remarks that before the Tarawera eruption of the previous year the presence of basic rocks in the Taupo volcanic zone was unknown.

Speight (1908) described in general terms the rocks of Tongariro National Park, including those of Ngauruhoe. He recorded the presence of hypersthene in all the lavas, and of small amounts of olivine in some of the later flows which, he remarked, have a basaltic aspect, but are hypersthene-andesites.

Grange, Williamson and Hurst, on their maps of the volcanoes, made between 1928 and 1930, distinguished a number of basaltic lava flows in the area west of Ngauruhoe, but unfortunately petrographic details have not been published. The lavas of Ngauruhoe itself are mapped as andesites.

The rock forming the new lava flow is a glassy hypersthene-augite-andesite which does not differ in any important way from those forming the other Recent flows in the upper part of Mangatepopo Valley.

Its texture is hyalopilitic. The microlitic glass of the groundmass, which is densely crowded with globulites and belonites, together with the tiny round vesicles (.025-.075 mm.) scattered through it, makes up nearly 73% of the rock.

Plagioclase crystals form $17\frac{1}{2}\%$ and range in size from well-shaped crystals 1.3 mm. long to microlites .01 mm. in length. The larger crystals are strongly zoned, the composition of their material ranging from $An_{65}$ in the central parts to $An_{39}$ in the outer zones. Often they contain zonally arranged inclusions of glass.

A little more than 8% of pyroxene is present and comprises hypersthene and clinopyroxene. Their relative proportions were not accurately determined in making the micrometric analysis, but hypersthene seems to be more plentiful than clinopyroxene. The hypersthene is weakly but distinctly pleochroic in pale brown and very pale green. The clinopyroxene is almost colourless but has a very faint yellowish tinge. In it the optic axial plane is parallel to 010 and the angle Z to c = 44°. The isogyre in section normal to an optic axis is well-curved and suggests an optic axial angle of about 45°. If this is so, the mineral lies somewhere about the dividing-line between augite and sub-calcic augite (Benson, 1944, Table ix, p. 112). In some cases hypersthene encloses remnants of augite crystals, while in others a strip of augite lies along each side of a lath of hypersthene, suggesting nothing so much as occupation by hypersthene of the central part of a twinned augite crystal.

Occasional crystals of olivine may be found, obviously much out of sympathy with their environment and surrounded by reaction rims of hypersthene and little digitate masses of iron ore.

The 1949 lava is very rich in inclusions. Remnants of these are to be found in almost every thin section and they occupied 1.57% of the micrometric traverses run. Although no special study of these has been made, a few notes may not be out of place.

Speight (1908, p. 8) noticed that "inclusions of what is apparently a partially fused rhyolite frequently occur in the lava flows of Ngauruhoe and Ruapehu" and thought that this, if confirmed, might afford proof of the existence of rhyolite below the volcanoes. Grange and Williamson (1930, p. 11) found, as inclusions in lava flows, fragments of greywacke and argillite such as build the Kaimanawa Ranges east of the volcanoes and Taurewa Mountain to the north-west.

One of the larger inclusions of the 1949 flow consists of patches of quartz mosaic (with grains up to .85 mm. across) in a matrix of lath-shaped crystals of wollastonite together with some granular diopside. This may, perhaps, represent the result of alteration of a sandy limestone from underlying beds of the mid- and upper Tertiary sequence, the nearest outcrops of which are in deep gorges 8 or 9 miles north-west of the volcano and around the flanks of Hauhangatahi, 9 miles to the west-south-west. There is limestone in this latter area.

The smaller inclusions, a few of which appear in most thin sections, are in many cases largely made up of little tablets of feldspar about .07 mm. long, varying in composition from basic andesine to medium labradorite in different cases. Little angular patches of glass crowded with fascicles of margarites occur interstially. There are also ill-formed and corroded crystals of hypersthene (up to 0.25 mm. in length in one

example), and ovoid patches of densely- crowded magnetite granules, resulting from the destruction of some ferro-magnesian mineral which, on the evidence of one inclusion, *may* be hypersthene. The origin of these inclusions is uncertain. The absence of quartz seems to negative the possibility of ther derivation from either greywacke or ignimbrite.

*Acknowledgments:* I wish to express my thanks to Miss M. Hurrey and Mr. A. P. Mason for their cheerful assistance (in spite of wretched weather) in mapping the new lava flow; to Mr. R. Cooper and Mr. L. R. Allen for their help in the field; and to Miss Pirie, who drew the figures.

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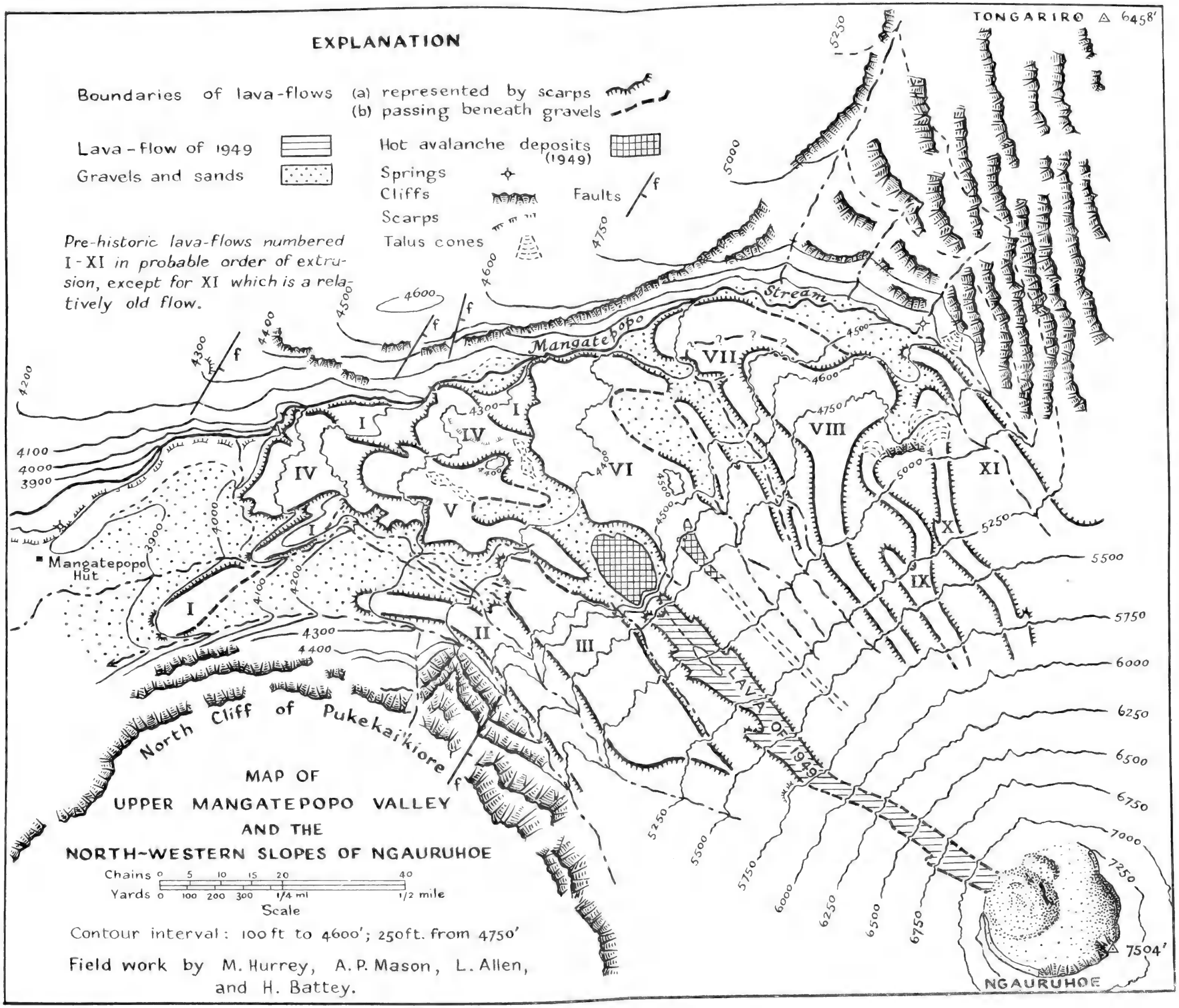
EXPLANATION
Boundaries of lava-flows (a) represented by scarps
(b) passing beneath gravels
Lava-flow of 1949
Gravels and sands
Hot avalanche deposits (1949)
Springs
Cliffs
Faults
Scarps
Talus cones
Pre-historic lava-flows numbered I-XI in probable order of extrusion, except for XI which is a relatively old flow.
TONGARIRO 6458′
Mangatepopo Stream
Mangatepopo Hut
North Cliff of Pukekaikiore
LAVA OF 1949
NGAURUHOE
7504′
MAP OF
UPPER MANGATEPOPO VALLEY
AND THE
NORTH-WESTERN SLOPES OF NGAURUHOE
Chains 0 5 10 15 20 40
Yards 0 100 200 300 1/4 mi 1/2 mile
Scale
Contour interval: 100 ft to 4600′; 250 ft. from 4750′
Field work by M. Hurrey, A. P. Mason, L. Allen, and H. Battey.

# Biological Primary Types in the Auckland Museum

## No. 2. Botanical.

By ROBERT COOPER, Botanist.

This paper is a list of the primary types* of plants in the Cheeseman Herbarium, Auckland Museum, and most of the entries are the names of new species and varieties described by Cheeseman. The entries are as originally published, although many have since been relegated to synonymy. The layout of the paper is similar to that of Powell, 1941 (Rec. Auck. Inst. Mus. 2: 239-259), which listed zoological primary types up to that date. A supplement, No. 3, provided by Powell, follows this list.

Cheeseman (Man. N.Z. Fl. Pref. iii-x, 1906) acknowledged the loan of material from the collections of other New Zealand botanists. He rarely based a description upon a single specimen and frequently cited material in other collections. Consequently a number of the syntype series of species in this list are incomplete.

Cheeseman (ibid) also acknowledged the valuable assistance he had from C. B. Clarke (Cyperaceae), Hackel (Gramineae) and Kukenthal (*Carex* and *Uncinia*). He cited each of them as the author of a number of names, but it is clear from the acknowledgment, and from the correspondence preserved in the herbarium, that Cheeseman wrote the published descriptions himself, and was responsible for them. Consequently the specimens which he examined and cited, in the descriptions of new species and varieties, have been classed as primary type material.

Cheeseman noted the label of some herbarium sheets that the material was a "type specimen" of a species described by Colenso. As Colenso sent his best material to Kew, it is unlikely that the specimens in the Cheeseman Herbarium are primary types, and they have been excluded from the list.

In 1930 a number of "type specimens" of species described by Cockayne were presented to the herbarium by that author. As it is possible that he used the term in an ecological sense (see Cockayne in Trans. N.Z. Inst. 49: 66-79, 1917), the names of the species have been omitted from the list.

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* Holotypes, syntype series, and lectotypes are listed. The type terms used in this paper are those recommended and defined by Frizzell (Amer. Midl. Nat. XIV: (6) 637-668, 1933):—

*Holotype:* A single specimen (or fragment) upon which a species is based.

*Syntype:* Any specimen of the author's original material when no holotype was designated; or any of a series of specimens described as "cotypes" of equal rank.

*Lectotype:* A syntype chosen, subsequently to the original description, to take the place which in other cases a holotype occupies.

In recent years, workers in the herbarium have indicated lectotypes of some species by notes on the herbarium sheets, but few of these selections have been published in revisions. Details of the selected specimens have not been added to this list, and further lectotypes have not been chosen, as a comprehensive set of rules on the selection of types is being framed and may be available after the 1950 International Botanical Congress (see Brittonia 7: 12, 1949).

The lectotypes of *Brachycome thomsonii* T. Kirk, *B. thomsonii* var. *membranifolia* T. Kirk, *B. thomsonii* var. *dubia* T. Kirk, *B. polita* T. Kirk, and *B. linearis* D. Petrie, chosen by Davis (Proc. Linn. Soc. N.S.W. 74: 97-106, 1949) have not been included, as Dr. W. R. B. Oliver has informed me that the types of these species and varieties are in the Dominion Museum.

The type material of several species is missing from the collections, but the names of these species are listed as the material may be found.

### *ALGAE.*

*Champia laingii* Lindauer in Trans. Roy. Soc N.Z. 67: 411, 1938 (holotype missing).

### *PTERIDOPHYTA.*

*Davallia tasmani* Field, Ferns N.Z. 75, 1890.
*Nephrodium leucorhachis* Cheesem. in Linn. Soc. Bot. Trans. 6: 309, 1903.

### *PHANEROGAMAE.*

*Aciphylla congesta* Cheesem. in Trans N.Z. Inst. 47: 44, 1915.
*Aciphylla indurata* Cheesem. in Trans. N.Z. Inst. 47: 40, 1915.
*Aciphylla monroi* Hook. f. var. *divisa* Cheesem in Trans. N.Z. Inst. 47: 42, 1915.
*Aciphylla multisecta* Cheesem. in Trans. N.Z. Inst. 47: 43, 1915.
*Aciphylla similis* Cheesem. in Trans. N.Z. Inst. 47: 42, 1915.
*Aciphylla spedeni* Cheesem. in Trans. N.Z. Inst. 45: 93, 1913.
*Aciphylla townsoni* Cheesem. Man. N.Z. Fl. 1138, 1906.
*Agropyrum multiflorum* T. Kirk var. *longisetum* Hack. ex Cheesem. Man. N.Z. Fl. 922, 1906.
*Agrostis dyeri* Petrie var. *aristata* Hack. ex Cheesem. Man N.Z. Fl. 865, 1906.
*Agrostis dyeri* Petrie var. *delicatior* Hack. ex Cheesem. Man. N.Z. Fl. 865, 1906.
*Agrostis muelleri* Benth. var. *paludosa* Hack. ex Cheesem. Man. N.Z. Fl. 864, 1906.
*Alectryon excelsum* D.C. var. *grandis* Cheesem. in Trans. N.Z. Inst. 24. 409, 1892.
*Alyxia elliptica* Cheesem. in Linn. Soc. Bot. Trans. 6: 287, 1903.
*Astelia nivicola* Cockayne ex Cheesem. Man N.Z. Fl. Ed. 2, 319, 1925
*Atropis chathamica* Cheesem. in Trans. N.Z. Inst. 53: 423, 1921.
*Atropis stricta* Hack. var. *suborbicularis* Hack. ex Cheesem. Man. N.Z. Fl. 915, 1906.
*Bagnisia (Geomitra) hilli* Cheesem. in Kew Bull. 420, 1908.
*Boehmeria dealbata* Cheesem. in Trans. N.Z. Inst. 24: 410, 1892.
*Brachyglottis arborescens* Oliver in Rec. Auck. Inst. Mus. 3: 236, 1948.
*Caladenia carnea* R. Br. var. *bartlettii* Hatch in Trans. Roy. Soc. N.Z. 77: 402, 1949.
*Caladenia minor* Hook. f. var. *exigua* Cheesem. Man. N.Z. Fl. 688, 1906.
*Caltha obtusa* Cheesem. in Trans. N.Z. Inst. 33: 312, 1901.
*Cardamine latesiliqua* Cheesem. in Trans. N.Z. Inst. 15: 298, 1883.
*Carex cinnamomea* Cheesem. in Trans. N.Z. Inst. 14: 301, 1882.
*Carex cirrhosa* Berggr. var. *lutescens* Kukenth. ex Cheesem. Man. N.Z. Fl. 825, 1906.
*Carex comans* Berggr. var. *stricta* Cheesem. in Trans. N.Z. Inst. 24: 415, 1892.
*Carex cryptocarpa* Cheesem. in Trans. N.Z. Inst. 16: 412, 1884.
*Carex devia* Cheesem. in Trans. N.Z. Inst. 15: 301, 1883.
*Carex dissita* Sol. ex Hook. f. var. *monticola* Kukenth. ex Cheesem. Man. N.Z. Fl. 831, 1906.
*Carex dissita* Sol. ex Hook. f. var. *ochrosaccus* C. B. Clarke ex Cheesem. Man. N.Z. Fl. 831, 1906.
*Carex inversa* R. Br. var. *radicata* Cheesem. in Trans. N.Z. Inst. 16: 425, 1884.

*Carex kirkii* Petrie var. *elatior* Kukenth. ex Cheesem. Man. N.Z. Fl. 811, 1906.
*Carex kirkii* Petrie var. *membranacea* Kukenth. ex Cheesem. Man. N.Z. Fl. 811, 1906.
*Carex petriei* Cheesem. in Trans. N.Z. Inst. 16: 413, 1884.
*Carex plesiostachys* C. B. Clarke ex Cheesem. Man N.Z. Fl. 829, 1906.
*Carex semi-forsteri* C. B. Clarke ex Cheesem. Man. N.Z. Fl. 836, 1906.
*Carex sinclairii* Boott. ex Cheesem. Man. N.Z. Fl. 820, 1906.
*Carex ternaria* Forst. var. *gracilis* Cheesem. in Trans. N.Z. Inst. 16; 431, 1884.
*Carex ternaria* Forst. var. *pallida* Cheesem. in Trans. N.Z. Inst. 16: 431, 1884.
*Carex trachycarpa* Cheesem. in Trans. N.Z. Inst. 24: 413, 1892.
*Carex uncifolia* Cheesem. in Trans. N.Z. Inst. 16; 412, 1884.
*Cassinia amoena* Cheesem. in Trans. N.Z. Inst. 29: 391, 1897.
*Celmisia adamsii* Kirk var. *rugulosa* Cheesem. Man. N.Z. Fl. 313, 1906.
*Celmisia brevifolia* Cockayne ex Cheesem. Man. N.Z. Fl. Ed. 2, 938, 1925.
*Celmisia compacta* Cheesem. Man. N.Z. Fl. Ed. 2, 955, 1925.
*Celmisia dubia* Cheesem. Man. N.Z. Fl. 308, 1906.
*Celmisia gibbsii* Cheesem. Man. N.Z. Fl. 300, 1906.
*Celmisia lateralis* Buch. var. *villosa* Cheesem. Man. N.Z. Fl. 302, 1906.
*Celmisia lyallii* Hook. f. var. *pseudo-lyallii* Cheesem. Man. N.Z. Fl. 312, 1906.
*Celmisia morgani* Cheesem. in Trans. N.Z. Inst. 46: 21, 1914.
*Celmisia petriei* Cheesem. Man. N.Z. Fl. 311, 1906.
*Celmisia rupestris* Cheesem. in Trans. N.Z. Inst. 16: 409, 1884.
*Celmisia thomsoni* Cheesem. in Trans. N.Z. Inst. 48: 211, 1916.
*Chordospartium stevensoni* Cheesem. in Trans. N.Z. Inst. 43: 175, 1911.
*Colobanthus muelleri* T. Kirk, var. *strictus* Cheesem. Man. N.Z. Fl. 68, 1906.
*Colobanthus squarrosus* Cheesem. in Trans. N.Z. Inst. 28: 534, 1896.
*Coprosma areolata* Cheesem. in Trans. N.Z. Inst. 18: 315, 1886.
*Coprosma benefica* Oliver in Bish. Mus. Bull. 132: 137, 1935.
*Coprosma kirkii* Cheesem. in Trans. N.Z. Inst. 29: 391, 1897.
*Coprosma laevigata* Cheesem. in Linn. Soc. Bot. Trans. 6: 283, 1903.
*Coprosma lucida* Forst. f. var. *angustifolia* Cheesem. Man. N.Z. Fl. Ed. 2, 859, 1925.
*Coprosma macrocarpa* Cheesem. in Trans. N.Z. Inst. 20: 147, 1888.
*Coprosma neglecta* Cheesem. in Trans. N.Z. Inst. 44: 160, 1912.
*Coprosma parviflora* Hook. f. var *dumosa* Cheesem. Man. N.Z. Fl. 254, 1906.
*Coprosma parviflora* Hook. f. var. *pilosa* Cheesem. in Trans. N.Z. Inst. 19: 242, 1887.
*Coprosma petriei* Cheesem. in Trans. N.Z. Inst. 18: 316, 1886.
*Coprosma rigida* Cheesem. in Trans. N.Z. Inst. 19: 243, 1887.
*Coprosma rugosa* Cheesem. Man. N.Z. Fl. 1141, 1906.
*Coprosma tenuicaulis* Hook. f. var. *major* Cheesem. Man. N.Z. Fl. 252, 1906.
*Coprosma tenuifolia* Cheesem in Trans. N.Z. Inst. 18: 315, 1886.
*Corokia buddleoides* A. Cunn. var. *linearis* Cheesem. Man. N.Z. Fl., Ed. 2, 686, 1925.
*Corybas macranthus* (Hook. f.) Reichb. f. var. *longipetalus* Hatch in Trans. Roy. Soc. N.Z. 76: 580, 1947.
*Corysanthes matthewsii* Cheesem. in Trans. N.Z. Inst. 31: 351, 1899.
*Corysanthes rotundifolia* Hook. f. var. *pandurata* Cheesem. Man. N.Z. Fl. Ed. 2, 366, 1925.
*Cotula dioica* Hook. f. var. *rotundata* Cheesem. Man. N.Z. Fl. 359, 1906.
*Cotula linearifolia* Cheesem. in Trans. N.Z. Inst. 15: 299, 1883.
*Cotula willcoxii* Cheesem. in Trans. N.Z. Inst. 48: 212, 1916.
*Cyrtandra rarotongensis* Cheesem. in Linn. Soc. Bot. Trans. 6: 290, 1903.
*Danthonia pungens* Cheesem. Man. N.Z. Fl. 887, 1906.
*Danthonia raoulii* Steud. var. *cheesemanii* Hack. ex Cheesem. Man. N.Z. Fl. 887, 1906.
*Deyeuxia avenoides* Buch. var. *brachyantha* Hack. ex Cheesem. Man. N.Z. Fl. 871, 1906.
*Deyeuxia billardieri* Kunth var. *tenuis* Petrie ex Cheesem. Man. N.Z. Fl. 870, 1906.
*Deyeuxia forsteri* Kunth var. *littoralis* Hack. ex Cheesem. Man. N.Z. Fl. 869, 1906.
*Deyeuxia forsteri* Kunth var. *micrathera* Hack. ex Cheesem. Man. N.Z. Fl. 869, 1906.
*Deyeuxia forsteri* Kunth var. *semiglabra* Hack. ex Cheesem. Man. N.Z. Fl. 869, 1906.
*Dichelachne crinita* Hook. f. var. *intermedia* Hack. ex Cheesem. Man. N.Z. Fl. 874, 1906.

*Dichelachne sciurea* Hook. f. var. *inaequiglumis* Hack. ex Cheesem. Man. N.Z. Fl. 874, 1906.
*Dracophyllum pubescens* Cheesem. Man. N.Z. Fl. 426, 1906.
*Dracophyllum rosmarinifolium* R. Br. var. *politum* Cheesem. Man N.Z. Fl. 427, 1906
*Dracophyllum townsoni* Cheesem. Man. N.Z. Fl. 420, 1906.
*Dracophyllum uniflorum* Hook. f. var. *acicularifolium* Cheesem. Man. N.Z. Fl. 427, 1906.
*Dracophyllum uniflorum* Hook. f. var. *virgatum* Cheesem. Man. N.Z. Fl. 427, 1906.
*Dracophyllum urvilleanum* A. Rich. var. *montanum* Cheesem. Man. N.Z. Fl. 424, 1906 .
*Drapetes dieffenbachii* Hook. var *laxa* Cheesem. Man. N.Z. Fl. 616, 1906.
*Drapetes villosa* Cheesem. var. *multiflora* Cheesem. Man. N.Z. Fl. 616, 1906.
*Earina aestivalis* Cheesem. in Trans. N.Z. Inst. 51: 93, 1919.
*Elaeocarpus dentatus* Vahl var. *obovatus* Cheesem. in Trans. N.Z. Inst. 39: 442, 1907.
*Epilobium nummularifolium* R. Cunn. ex A. Cunn. var. *angustum* Cheesem. Man. N.Z. Fl. 180, 1906.
*Epilobium rostratum* Cheesem. in Trans. N.Z. Inst. 28: 534, 1896.
*Epilobium vernicosum* Cheesem. in Trans. N.Z. Inst. 28: 535, 1896.
*Fitchia speciosa* Cheesem. in Linn. Soc. Bot. Trans. 6: 284, 1903.
*Forstera sedifolia* Linn. f. var. *oculata* Cheesem. Man. N.Z. Fl. 393, 1906.
*Gaultheria rupestris* R. Br. var. *lanceolata* Cheesem. Man. N.Z. Fl. 407, 1906.
*Geniostoma ligustrifolium* A. Cunn. var. *crassum* Cheesem. in Trans. N.Z. Inst. 29: 392, 1887.
*Geniostoma ligustrifolium* A. Cunn. var. *major* Cheesem. Man. N.Z. Fl. 444, 1906.
*Gentiana filipes* Cheesem. in Trans. N.Z. Inst. 28: 536, 1896.
*Gentiana gracilifolia* Cheesem. Man. N.Z. Fl. 1144, 1906.
*Gentiana montana* Forst. var. *stolonifera* Cheesem. Man. N.Z. Fl. 451, 1906
*Gentiana townsoni* Cheesem. Man. N.Z. Fl. 450, 1906.
*Gentiana vernicosa* Cheesem. Man. N.Z. Fl. 1145, 1906.
*Geum divergens* Cheesem. in Trans. N.Z. Inst. 48: 210, 1916.
*Habenaria amplifolia* Cheesem. in Linn. Soc. Bot. Trans. 6: 298, 1903.
*Haloragis cartilaginea* Cheesem. in Trans. N.Z. Inst. 29: 390, 1897.
*Helichrysum selago* Benth. & Hook. f. var. *acuta* Cheesem. Man. N.Z. Fl. Ed 2, 985, 1925 (missing).
*Helichrysum selago* Benth. & Hook. f. var *tomentosum* Cheesem. Man. N.Z. Fl. 343, 1906.
*Helichrysum selago* Benth. & Hook. f. var. *tuberculata* Cheesem. Man. N.Z. Fl. Ed. 2, 985, 1925 (missing).
*Helichrysum selago* Benth. & Hook. f. var. *tumida* Cheesem. Man. N.Z. Fl., Ed. 2, 986, 1925 (missing).
*Hierochloe fraseri* Hook. f. var. *recurvata* Hack. ex Cheesem. Man. N.Z. Fl. 856, 1906.
*Homalium acuminatum* Cheesem. in Linn. Soc. Bot. Trans. 6: 280, 1903.
*Ixora bracteata* Cheesem. in Linn. Soc. Bot. Trans. 6: 283, 1903.
*Juncus pallidus* R. Br. var. *triandrus* Cheesem. Man. N.Z. Fl. 725, 1906.
*Lepidium tenuicaule* T Kirk var. *minor* Cheesem. in Trans. N.Z. Inst. 43: 175, 1911.
*Ligusticum capillifolium* Cheesem. in Trans. N.Z. Inst. 47: 45, 1915.
*Ligusticum deltoideum* Cheesem. in Trans. N.Z. Inst. 14: 299, 1882.
*Ligusticum diversifolium* Cheesem. Man. N.Z. Fl. 1139, 1906.
*Ligusticum petraeum* Cheesem. in Trans. N.Z. Inst. 51: 92, 1919.
*Loranthus adamsii* Cheesem. in Trans. N.Z. Inst. 13: 296, 1881.
*Melicytus micranthus* Hook. f. var. *longiusculus* Cheesem. Man. N.Z. Fl. 48, 1906.
*Microlaena carsei* Cheesem. in Trans. N.Z. Inst. 47: 47, 1915.
*Myosotis amabilis* Cheesem. Man. N.Z. Fl. 468, 1906.
*Myosotis angustata* Cheesem. Man. N.Z. Fl. 465, 1906.
*Myosotis astoni* Cheesem in Trans. N.Z. Inst. 42: 217, 1910.
*Myosotis australis* R. Br. var. *conspicua* Cheesem. Man. N.Z. Fl. 462, 1906.
*Myosotis concinna* Cheesem. in Trans. N.Z. Inst. 17: 235, 1885.
*Myosotis decora* T. Kirk ex Cheesem. Man. N.Z. Fl. 462, 1906.
*Myosotis explanata* Cheesem. Man. N.Z. Fl. 464, 1906.
*Myosotis laeta* Cheesem. in Trans. N.Z. Inst. 17: 236, 1885.
*Myosotis laingii* Cheesem. in Trans. N.Z. Inst. 44: 161, 1912.
*Myosotis macrantha* Hook. f. & Benth. var. *pulchra* Cheesem. Man. N.Z. Fl. 471, 1906.

*Myosotis monroi* Cheesem. Man. N.Z. Fl. 469, 1906.
*Myosotis townsoni* Cheesem. Man. N.Z. Fl. 1145, 1906.
*Myrsine kermadecensis* Cheesem. in Trans. N.Z. Inst. 24: 410, 1892.
*Nasturtium gibbsii* Cheesem. in Trans. N.Z. 54: 565, 1923.
*Nothopanax macintyrei* Cheesem. Man. N.Z. Fl., Ed. 2, 636, 1925.
*Olearia insignis* Hook. f. var. *minor* Cheesem. in Trans. N.Z. Inst. 48: 210, 1916.
*Olearia nitida* Hook. f. var. *angustifolia* Cheesem. Man. N.Z. Fl. 285, 1906.
*Olearia pachyphylla* Cheesem. in Trans. N.Z. Inst. 42: 216, 1910.
*Olearia suavis* Cheesem. in Trans. N.Z. Inst. 24: 409, 1892.
*Olearia thomsoni* Cheesem. Man. N.Z. Fl. Ed. 2, 918, 1925.
*Olearia townsoni* Cheesem. Man. N.Z. Fl. Ed. 2, 917, 1925.
*Paratrophis (Uromorus) smithii* Cheesem. in Trans. N.Z. Inst. 20: 148, 1888.
*Pimelea aridula* Cockayne var. *linearis* Cheesem. Man. N.Z. Fl. Ed. 2, 583, 1925 (missing).
*Pimelea gnidia* Willd. var. *pulchella* Cheesem. Man. N.Z. Fl. 609, 1906.
*Pimelea lyallii* Hook. f. var. *sericea* Cheesem. Man. N.Z. Fl. 614, 1906 (missing).
*Piper excelsum* Forst. var. *major* Cheesem. Man. N.Z. Fl. 595, 1906.
*Pittosporum dallii* Cheesem. Man. N.Z. Fl. 1134, 1906.
*Pittosporum ellipticum* T. Kirk var. *decorum* Cheesem. Man. N.Z. Fl. Ed. 2, 491, 1925.
*Pittosporum fairchildii* Cheesem. in Trans. N.Z. Inst. 20: 147, 1888.
*Pittosporum pimeleoides* R. Cunn. ex A. Cunn. var. *major* Cheesem. Man. N.Z. Fl. 60, 1906.
*Plantago lanigera* Hook. f. var. *petriei* Cheesem. Man. N.Z. Fl. 572, 1906.
*Plantago masonae* Cheesem. in Trans. N.Z. Inst. 53: 424, 1921.
*Plectomirtha baylisiana* Oliver in Rec. Auck. Inst. Mus. 3: 225, 1948.
*Poa anceps* Forst. var. *condensata* Cheesem. Man. N.Z. Fl. 904, 1906.
*Poa anceps* Forst. var. *gracilis* Cheesem. Man. N.Z. Fl. 904, 1906.
*Poa caespitosa* Forst. var. *leioclada* Hack. ex Cheesem. Man. N.Z. Fl. 908, 1906.
*Poa kirkii* Buch. var. *collinsii* Hack. ex Cheesem. Man. N.Z. Fl. 910, 1906.
*Pomaderris rugosa* Cheesem. in Trans. N.Z. Inst. 54: 566, 1923.
*Pterostylis furcata* Ldl. var. *linearis* Hatch in Trans. Roy. Soc. N.Z. 77: 243, 1949.
*Pterostylis graminea* Hook. f. var. *rubricaulis* H. B. Matthews ex Cheesem. Man. N.Z. Fl. Ed. 2, 351, 1925.
*Pterostylis humilis* Rog. Trans. Roy. Soc. S. Austr. 46: 151, 1922.
*Pterostylis matthewsii* Cheesem. in Trans. N.Z. Inst. 47: 46, 1915.
*Pterostylis montana* Hatch var. *typica* Hatch in Trans. Roy. Soc. N.Z. 77: 239, 1949.
*Pterostylis trullifolia* Hook. f. var. *alobula* Hatch in Trans. Roy. Soc. N.Z. 77: 244, 1949.
*Pterostylis trullifolia* Hook. f. var. *gracilis* Cheesem. in Trans. N.Z. Inst. 47: 46, 1915.
*Ranunculus hirtus* Banks & Sol.. ex Forst. var. *elongatus* Cheesem. Man. N.Z. Fl. 19, 1906.
*Ranunculus matthewsii* Cheesem. Man. N.Z. Fl. 1133, 1906.
*Ranunculus tenuicaulis* Cheesem. in Trans. N.Z. Inst. 17: 235, 1885.
*Raoulia gibbsii* Cheesem. in Trans. N.Z. Inst. 42: 216, 1910.
*Schizeilema allanii* Cheesem. Man. N.Z. Fl. Ed. 2, 651, 1925.
*Schoenus carsei* Cheesem. Man. N.Z. Fl. 781, 1906.
*Scirpus inundatus* Poir. var. *gracillima* Cheesem. Man. N.Z. Fl. 775, 1906.
*Scirpus inundatus* Poir. var. *major* Cheesem. Man. N.Z. Fl. 775, 1906.
*Sclerotheca viridiflora* Cheesem. in Linn. Soc. Bot. Trans. 6: 285, 1903.
*Senecio glaucophylla* Cheesem. in Trans. N.Z. Inst. 28: 536, 1896.
*Senecio lapidosus* Cheesem. in Trans. N.Z. Inst. 48: 212, 1916.
*Senecio lautus* Forst. var. *discoideus* Cheesem. Man. N.Z. Fl. 374, 1906.
*Senecio lautus* Forst. var. *montanus* Cheesem. Man. N.Z. Fl. 373, 1906.
*Senecio myrianthos* Cheesem. in Trans. N.Z. Inst. 7: 348, 1875 (missing).
*Senecio pachyphyllus* Cheesem. in Trans. N.Z. Inst. 16: 410, 1884.
*Senecio rotundifolius* Hook. f. var. *ambiguus* Cheesem. Man. N.Z. Fl. Ed. 2, 1026, 1925.
*Senecio turneri* Cheesem. in Trans. N.Z. Inst. 43: 176, 1911.
*Solanum aviculare* Forst. var. *albiflora* Cheesem. in Trans. N.Z. Inst. 52: 11, 1920.
*Suttonia dentata* Oliver in Rec. Auck. Inst. Mus. 3: 230, 1948.
*Tecomanthe speciosa* Oliver in Rec. Auck. Inst. Mus. 3: 233, 1948.
*Teucridium parvifolium* Hook. f. var. *luxurians* Cheesem. Man. N.Z. Fl. Ed. 2, 764, 1925.

*Thelymitra aemula* Cheesem. in Trans. N.Z. Inst. 51: 94, 1919.
*Thelymitra decora* Cheesem. Man. N.Z. Fl. 1151, 1906.
*Thelymitra matthewsii* Cheesem. in Trans. N.Z. Inst. 43: 177, 1911 (missing).
*Thelymitra pachyphylla* Cheesem. Man. N.Z. Fl. 1151, 1906.
*Townsonia deflexa* Cheesem. Man. N.Z. Fl. 692, 1906.
*Triodia australis* Petrie var. *mucronulata* Hack ex Cheesem. Man. N.Z. Fl. 897, 1906.
*Triodia macquariensis* Cheesem. Vasc. Fl. Macquarie Is. Austr. Antarct. Exped. Sci. Rep. Ser. C. 7 (3): 34, 1919.
*Trisetum antarcticum* Trin. var. *lasiorhachis* Hack. ex Cheesem. Man. N.Z. Fl. 880, 1906.
*Trithuria (?) inconspicua* Cheesem. Man. N.Z. Fl. 756, 1906.
*Uncinia australis* Pers. var. *clavata* Kukenth. ex Cheesem. Man. N.Z. Fl. 802, 1906.
*Uncinia compacta* R. Br. var. *petriei* C. B. Clarke ex Cheesem. Man. N.Z. Fl. 800, 1906.
*Uncinia sinclairii* Boott ex Hook. f. var. *elegans* Kukenth. ex Cheesem. Man. N.Z. Fl. 799, 1906.
*Utricularia delicatula* Cheesem. Man. N.Z. Fl. 561, 1906.
*Utricularia mairii* Cheesem. Man. N.Z. Fl. 560, 1906.
*Veronica adamsii* Cheesem. Man. N.Z. Fl. Ed. 2, 786, 1925.
*Veronica amabilis* Cheesem. var. *blanda* Cheesem. Man. N.Z. Fl. 506, 1906.
*Veronica buchanani* Hook f. var. *exigua* Cheesem. Man. N.Z. Fl. 527, 1906.
*Veronica buchanani* Hook. f. var. *major* Cheesem. Man. N.Z. Fl. 527, 1906.
*Veronica coarctata* Cheesem. Man. N.Z. Fl. 531, 1906.
*Veronica cockayniana* Cheesem. Man. N.Z. Fl. 522, 1906.
*Veronica divergens* Cheesem. Man. N.Z. Fl. 502, 1906.
*Veronica insularis* Cheesem. in Trans. N.Z. Inst. 29: 392, 1897.
*Veronica macrantha* Hook. f. var. *brachyphylla* Cheesem. Man. N.Z. Fl. 537, 1906.
*Veronica macrocarpa* Vahl var. *affinis* Cheesem. Man. N.Z. Fl. 505, 1906.
*Veronica macrocarpa* Vahl var. *crassifolia* Cheesem. Man. N.Z. Fl. 505, 1906.
*Veronica macroura* Hook. f. ex Benth. var. *dubia* Cheesem. Man. N.Z. Fl. 501, 1906.
*Veronica matthewsii* Cheesem. Man. N.Z. Fl. 517, 1906.
*Veronica menziesii* Benth. var. *divaricata* Cheesem. Man. N.Z. Fl. 512, 1906.
*Veronica rigidula* Cheesem. Man. N.Z. Fl. 514, 1906.
*Veronica rupicola* Cheesem. Man. N.Z. Fl. 514, 1906.
*Veronica speciosa* R. Cunn. var. *brevifolia* Cheesem. Man. N.Z. Fl. 500, 1906.
*Veronica thomsoni* Cheesem. var. *glabra* Cheesem. Man. N.Z. Fl. 540, 1906.
*Veronica traversii* Hook. f. var. *elegans* Cheesem. Man. N.Z. Fl. 519, 1906.
*Veronica traversii* Hook. f. var. *fallax* Cheesem. Man. N.Z. Fl. 519, 1906.
*Veronica vernicosa* Hook. f. var. *gracilis* Cheesem. Man. N.Z. Fl. 520, 1906.
*Veronica vernicosa* Hook. f. var. *multiflora* Cheesem. Man. N.Z. Fl. 520, 1906.
*Wahlenbergia saxicola* A.D.C. var. *congesta* Cheesem. Man. N.Z. Fl. 403, 1906.

# Biological Primary Types in the Auckland Museum

## No. 3. Zoological (supplement).

By A. W. B. POWELL, Assistant Director.

In this number, which brings the list of zoological types up to date, a further 312 primary types are listed. The complete list of zoological types in the Auckland Museum now totals 1,530 entries. Of this number 201 are in the Powell loan collection of mollusca, and these are indicated by an asterisk. Fossils are preceded by the symbol †. In all cases the entries are generically alphabetic under Phyla, and as originally published.

In No. 1 of this series (Powell, 1941, Rec. Auck. Inst. Mus. 2 (5): 239-259) six holotypes were listed as missing, but one of these, *Tainuia aucklandica* Marshall, 1926, has since been located. In the present supplement two additional holotypes, published as belonging to the Auckland Museum, are not in the collections. They are *Besla rossiana* Laws, 1941, and *Levipyrgulina sulcata* Laws, 1941.

### ANNELIDA.

*Notoscolex equestris* Benham, 1942. Trans. Roy. Soc. N.Z., 72, p. 220.

### ECHINODERMA.

*Brissus gigas* Fell, 1947. Rec. Auck. Inst. Mus. 3 (3), p. 145.

### MOLLUSCA.

*Allodiscus turbotti* Powell, 1948. Rec. Auck. Inst. Mus. 3 (4-5), p. 276.
†*Anacithara clifdenica* Powell, 1942. Bull. Auck. Inst. Mus. 2, p. 155.
†*Anacithara errabunda* Powell, 1942. Bull. Auck. Inst. Mus. 2, p. 156.
†*Anacithara finlayi* Powell, 1942. Bull. Auck. Inst. Mus. 2, p. 156.
†*Anacithara janjukiensis* Powell, 1944. Rec. Auck. Inst. Mus. 3 (1), p. 58.
†*Anacithara nana* Powell, 1942. Bull. Auck. Inst. Mus. 2, p. 156.
**Anticomitas vivens* Powell, 1942. Bull. Auck. Inst. Mus. 2, p. 61.
†*Antiguraleus deceptus* Powell, 1942. Bull. Auck. Inst. Mus. 2, p. 146.
*Antiguraleus fenestratus* Powell, 1942. Bull. Auck. Inst. Mus. 2, p. 148.
*Antiguraleus otagoensis* Powell, 1942. Bull. Auck. Inst. Mus. 2, p. 147.
*Antiguraleus pedicus* Powell, 1942. Bull. Auck. Inst. Mus. 2, p. 148.
*Antiguraleus rossianus* Powell, 1942. Bull. Auck. Inst. Mus. 2, p. 148.
*Antiguraleus subtruncatus* Powell, 1942. Bull. Auck. Inst. Mus. 2, p. 147.
**Antimelatoma ahiparana* Powell, 1942. Bull. Auck. Inst. Mus. 2, p. 98.
*Antimelatoma benthicola* Powell, 1942. Bull. Auck. Inst. Mus. 2, p. 98.
†*Aoteadrillia bisecta* Powell, 1942. Bull. Auck. Inst. Mus. 2, p. 92.
†*Aoteadrillia finlayi* Powell, 1942. Bull. Auck. Inst. Mus. 2, p. 93.
*Aoteadrillia otagoensis* Powell, 1942. Bull. Auck. Inst. Mus. 2, p. 89.
**Aoteadrillia rawitensis* (Hedley, 1922): Powell, 1942. Bull. Auck. Inst. Mus. 2, p. 89 (Neotype).
†*Aoteadrillia thomsoni* Powell, 1942. Bull. Auck. Inst. Mus. 2, p. 90.
†*Apiotoma balcombensis* Powell, 1944. Rec. Auck. Inst. Mus. 3 (1), p. 20.
†*Apiotoma chapplei* Powell, 1944. Rec. Auck. Inst. Mus. 3 (1), p. 21.
†*Apiotoma pritchardi* Powell, 1944. Rec. Auck. Inst. Mus. 3 (1), p. 20.

†*Asperdaphne balcombensis* Powell, 1944. Rec. Auck. Inst. Mus. 3 (1), p. 59.
†*Asperdaphne contigua* Powell, 1944. Rec. Auck. Inst. Mus. 3 (1), p. 60.
†*Asperdaphne (Aspertilla) exsculpta* Powell, 1944. Rec. Auck. Inst. Mus. 3 (1), p. 60.
†*Austroclavus awakinoensis* Powell, 1942. Bull. Auck. Inst. Mus. 2, p. 120.
†*Austroclavus brevicaudalis* Powell, 1944. Rec. Auck. Inst. Mus. 3 (1), p. 40.
†*Austroclavus clifdenensis* Powell, 1942. Bull. Auck. Inst. Mus. 2, p. 119.
†*Austroclavus finlayi* Powell, 1942. Bull. Auck. Inst. Mus. 2, p. 119.
†*Austroclavus glaber* Powell, 1944. Rec. Auck. Inst. Mus. 3 (1), p. 40.
†*Austroclavus lygdinopsis* Powell, 1944. Rec. Auck. Inst. Mus. 3 (1), p. 41.
†*Austroclavus marshalli* Powell, 1942. Bull. Auck. Inst. Mus. 2, p. 120.
†*Austroclavus teres* Powell, 1944. Rec. Auck. Inst. Mus. 3 (1), p. 40.
**Austrodrillia (Regidrillia) sola* Powell, 1942. Bull. Auck. Inst. Mus. 2, p. 99.
†*Austrotoma clifdenica* Powell, 1942. Bull. Auck. Inst. Mus. 2, p. 74.
†*Austrotoma cryptoconoidea* Powell, 1942. Bull. Auck. Mus. 2, p. 75.
†*Austrotoma echinata* Powell, 1942. Bull. Auck. Inst. Mus. 2, p. 74.
†*Austrotoma gemmulata* Powell, 1942. Bull. Auck. Inst. Mus. 2, p. 76.
†*Austrotoma inexpectata* Powell, 1944. Rec. Auck. Inst. Mus. 3 (1), p. 23.
†*Austrotoma janjukiensis* Powell, 1944. Rec. Auck. Inst. Mus. 3 (1), p. 24.
†*Austrotoma kaiparaensis* Powell, 1942. Bull. Inst. Mus. 2, p. 73.
†*Austrotoma lawsi* Powell, 1942. Bull. Auck. Inst. Mus. 2, p. 75.
†*Austrotoma nervosa* Powell, 1942. Bull. Auck. Inst. Mus. 2, p. 76.
†*Bassina katherinae* Marwick, 1948. N.Z. Geol. Surv. Pal. Bull. 16, p. 24.
†*Belatomina clathrata* Powell, 1944. Rec. Auck. Inst. Mus. 3 (1), p. 25.
*Besla rossiana* Laws, 1941. Trans. Roy. Soc. N.Z. 71, p. 13 (missing).
†*Besla vaga* Laws, 1941. Trans. Roy. Soc. N.Z. 71, p. 12.
†*Borsonia tatei* Powell, 1944. Rec. Auck. Inst. Mus. 3 (1), p. 42.
†*Borsonia torquayensis* Powell, 1944. Rec. Auck. Inst. Mus. 3 (1), p. 42.
†*Chione (Austrovenus) tamakiensis* Marwick, 1948. N.Z. Geol. Surv. Pal. Bull. 16, p. 24.
†*Cominella (Acominia) dingleyi* Marwick, 1948. N.Z. Geol. Surv. Pal. Bull. 16, p. 31.
†*Cominella (Cominista) altispira* Marwick, 1948. N.Z. Geol. Surv. Pal. Bull. 16, p. 31.
*Cominella (Eucominia) haroldi* Powell, 1946. Rec. Auck. Inst. Mus. 3 (2), p. 142.
*Cominella (Eucominia) marlboroughensis* Powell, Rec. Auck. Inst. Mus. 3 (2), p. 143.
*Cominella (Eucominia) nassoides foveauxana* Powell, 1946. Rec. Auck. Inst. Mus. 3 (2), p. 142.
*Cominella (Eucominia) otakauica* Powell, 1946. Rec. Auck. Inst. Mus. 3 (2), p. 143.
†*Comitas allani* Powell, 1942. Bull. Auck. Inst. Mus. 2, p. 59.
†*Comitas pseudoclarae* Powell, 1944. Rec. Auck. Inst. Mus. 3 (1), p. 18.
†*Comitas torquayensis* Powell, 1944. Rec. Auck. Inst. Mus. 3 (1), p. 17.
†*Comitas (Carinacomitas) aldingensis* Powell, 1944. Rec. Auck. Inst. Mus. 3 (1), p. 18.
†*Comitas (Carinacomitas) subcarinapex* Powell, 1942. Bull. Auck. Inst. Mus. 2, p. 60.
†*Coralliophila turneri* Laws, 1941. Trans. Roy. Soc. N.Z. 71, p. 150.
†*Coronasyrinx semiplana* Powell, 1944. Rec. Auck. Inst. Mus. 3 (1), p. 22.
†*Coronasyrinx venusta* Powell, 1944. Rec. Auck. Inst. Mus. 3 (1), p. 22.
†*Cryptoborsonia pleurotomella* Powell, 1944. Rec. Auck. Inst. Mus. 3 (1), p. 43.
†*Cryptoborsonia rugobela* Powell, 1944. Rec. Auck. Inst. Mus. 3 (1), p. 43.
†*Cryptodaphne pseudodrillia* Powell, 1942. Bull. Auck. Inst. Mus. 2, p. 165.
†*Daphnella chapplei* Powell, 1944. Rec. Auck. Inst. Mus. 3 (1), p. 59.
†*Dosinia (Raina) powelli* Marwick, 1948. N.Z. Geol. Surv. Pal. Bull. 16, p. 24.
†*Egila arcuata* Laws, 1941. Trans. Roy. Soc. N.Z. 71, p. 14.
†*Eoscobinella tahuia* Powell, 1942. Bull. Auck. Inst. Mus. 2, p. 122.
†*Etrema exsculpta* Powell, 1944. Rec. Auck. Inst. Mus. 3 (1), p. 54.
†*Etrema gippslandensis* Powell, 1944. Rec. Auck Inst. Mus. 3 (1), p. 54.
†*Etrema granolirata* Powell, 1944. Rec. Auck. Inst. Mus. 3 (1), p. 52.
†*Etrema janjukiensis* Powell, 1944. Rec. Auck. Inst. Mus. 3 (1), p. 52.
†*Etrema mirabilis* Powell, 1944. Rec. Auck. Inst. Mus. 3 (1), p. 54.
†*Etremopsis aequisculpta* Powell, 1942. Bull. Auck. Inst. Mus. 2, p. 153.
†*Etremopsis carinapex* Powell, 1942. Bull. Auck. Inst. Mus. 2, p. 153.

†*Etremopsis clifdenica* Powell, 1942. Bull. Auck. Inst. Mus. 2, p. 152.
†*Etremopsis compta* Powell, 1942. Bull. Auck. Inst. Mus. 2, p. 152.
†*Etremopsis contigua* Powell, 1944. Rec. Auck. Inst. Mus. 3 (1), p. 55.
†*Etremopsis elata* Powell, 1942. Bull. Auck. Inst. Mus. 2, p. 153.
†*Etremopsis erecta* Powell, 1942. Bull. Auck. Inst. Mus. 2, p. 152.
†*Etremopsis haroldi* Powell, 1942. Bull. Auck. Inst. Mus 2, p. 154.
†*Etremopsis latiapex* Powell, 1942. Bull. Auck. Inst. Mus. 2, p. 154.
†*Etremopsis oamarutica* Powell, 1942. Bull. Auck. Inst. Mus. 2, p. 154.
†*Etremopsis opposita* Powell, 1944. Rec. Auck. Inst. Mus. 3 (1), p. 55.
†*Etremopsis quadrispiralis* Powell, 1942. Bull. Auck. Inst. Mus. 2, p. 154.
†*Eubela awakinoensis* Powell, 1942. Bull. Auck. Inst. Mus, 2, p. 165.
†*Eumarcia (Opimarcia) healyi* Marwick, 1948. N.Z. Geol. Surv. Pal. Bull. 16, p. 26.
*Evalea plana* Laws, 1941. Trans. Roy. Soc. N.Z. 71, p. 21.
*Evalea propria* Laws, 1941. Trans. Roy. Soc. N.Z. 71, p. 22.
†*Fenestrodaphne pulchra* Powell, 1944. Rec. Auck. Inst. Mus. 3 (1), p. 61.
†*Filodrillia ludbrookae* Powell, 1944. Rec. Auck. Inst. Mus. 3 (1), p. 57.
†*Filodrillia turricula* Powell, 1944. Rec. Auck. Inst. Mus. 3 (1), p. 56.
†*Gari aucklandica* Marwick, 1948. N.Z. Geol. Surv. Pal. Bull. 16, p. 26
†*Gemmula clifdenensis* Powell, 1942. Bull. Auck. Inst. Mus. 2, p. 49.
†*Guraleus adelaidensis* Powell, 1944. Rec. Auck. Inst. Mus. 3 (1), p. 49.
†*Guraleus chapplei* Powell, 1944. Rec. Auck. Inst. Mus. 3 (1), p. 47.
†*Guraleus harrisi* Powell, 1944. Rec. Auck. Inst. Mus. 3 (1), p. 48.
†*Guraleus janjukiensis* Powell, 1944. Rec. Auck. Inst. Mus. 3 (1), p. 47.
†*Guraleus ludbrookae* Powell, 1944. Rec. Auck. Inst. Mus. 3 (1), p. 47.
†*Guraleus singletoni* Powell, 1944. Rec. Auck. Inst. Mus. 3 (1), p. 48.
†*Guraleus (Paraguraleus) abbreviatus* Powell, 1944. Rec. Auck. Inst. Mus. 3 (1), p. 50.
†*Guraleus (Paraguraleus) balcombensis* Powell, 1944. Rec. Auck. Inst. Mus. 3 (1), p. 50.
†*Guraleus (Paraguraleus) finlayi* Powell, 1944. Rec. Auck. Inst. Mus. 3 (1), p. 50.
†*Guraleus (Paraguraleus) incisus* Powell, 1944. Rec. Auck. Inst. Mus. 3 (1), p. 51.
†*Heterocithara miocenica* Powell, 1944. Rec. Auck. Inst. Mus. 3 (1), p. 57.
†*Inquisitor waihaoensis* Powell, 1942. Bull. Auck. Inst. Mus. 2, p. 95.
†*Insolentia elegantula* Powell, 1942. Bull. Auck. Inst. Mus. 2, p. 64.
*Laoma labyrinthica* Powell, 1948. Rec. Auck. Inst. Mus. 3 (4-5), p. 277.
*Laomarex sericea* Powell, 1948. Rec. Auck. Inst. Mus. 3 (4-5), p. 279.
†*Laternula synthetica* Marwick, 1948. N.Z. Geol. Surv. Pal. Bull. 16, p. 27.
†*Levipyrgulina marginata* Laws, 1941. Trans. Roy. Soc. N.Z. 71, p. 17.
†*Levipyrgulina sulcata* Laws, 1941. Trans. Roy. Soc. N.Z. 71, p. 17 (missing).
†*Linopyrga junior* Laws, 1941. Trans. Roy. Soc. N.Z. 71, p. 9.
†*Linopyrga sanguis* Laws, 1941. Trans. Roy. Soc. N.Z. 71, p. 10.
**Liracraea odhneri* Powell, 1942. Bull. Auck. Inst. Mus. 2, p. 150.
*Liracraea otakauica* Powell, 1942. Bull. Auck. Inst. Mus. 2, p. 149.
**Liracraea subantarctica* Powell, 1942. Bull. Auck. Inst. Mus. 2, p. 149.
†*Liratomina adelaidensis* Powell, 1944. Rec. Auck. Inst. Mus. 3 (1), p. 27.
†*Liratomina intertexta* Powell, 1944. Rec. Auck. Inst. Mus. 3 (1), p. 26.
†*Mactra (Cyclomactra) williamsi* Marwick, 1948. N.Z. Geol. Surv. Pal. Bull. 16, p. 22.
†*Maoridaphne haroldi* Powell, 1942. Bull. Auck. Inst. Mus. 2, p. 163.
*Maorimorpha secunda* Powell, 1942. Bull. Auck. Inst. Mus. 2, p. 126.
†*Maoritomella annosa* Powell, 1942. Bull. Auck. Inst. Mus. 2, p. 114.
†*Maoritomella balcombensis* Powell, 1944. Rec. Auck. Inst. Mus. 3 (1), p. 39.
†*Maoritomella equispiralis* Powell, 1944. Rec. Auck. Inst. Mus. 3 (1), p. 39.
†*Maoritomella nutans* Powell, 1944. Rec. Auck. Inst. Mus. 3 (1), p. 39.
†*Maoritomella pukeuriensis* Powell, 1942. Bull. Auck. Inst. Mus. 2, p. 114.
†**Maoritomella sola* Powell, 1942. Bull. Auck. Inst. Mus. 2, p. 114.
†*Marshallaria waitakiensis* Powell, 1942. Bull. Auck. Inst. Mus. 2, p. 81.
†*Marshallena anomala* Powell, 1942. Bull. Auck. Inst. Mus. 2, p. 83.
†*Mauidrillia aldingensis* Powell, 1944. Rec. Auck. Inst. Mus. 3 (1), p. 36.
†*Mauidrillia angustata* Powell, 1942. Bull. Auck. Inst. Mus. 2, p. 87.
†*Mauidrillia clavicula* Powell, 1942. Bull. Auck. Inst. Mus. 2, p. 86.
†*Mauidrillia imparilirata* Powell, 1942. Bull. Auck. Inst. Mus. 2, p. 86.
†*Mauidrillia inaequalis* Powell, 1942. Bull. Auck. Inst. Mus. 2. p. 86.
†*Mauidrillia intumescens* Powell, 1944. Rec. Auck. Inst. Mus. 3 (1), p. 37.

†*Mauidrillia partinoda* Powell, 1944. Rec. Auck. Inst. Mus. 3 (1), p. 35.
†*Mauidrillia secta* Powell, 1944. Rec. Auck. Inst. Mus. 3 (1), p. 37.
†*Mauidrillia serrulata* Powell, 1944. Rec. Auck. Inst. Mus. 3 (1), p. 36.
†*Mauidrillia supralaevis* Powell, 1942. Bull. Auck. Inst. Mus. 2, p. 86.
†*Mauidrillia torquayensis* Powell, 1944. Rec. Auck. Inst. Mus. 3 (1), p. 35.
†*Mauidrillia trispiralis* Powell, 1944. Rec. Auck. Inst. Mus. 3 (1), p. 36.
†*Mauidrillia unilirata* Powell, 1942. Bull. Auck. Inst. Mus. 2, p. 87.
*Maurea pellucida morioria* Powell, 1946. Rec. Auck. Inst. Mus. 3 (2), p. 140.
†*Micantapex parri* Powell, 1944. Rec. Auck. Inst. Mus. 3 (1), p. 15.
†*Micantapex perarmatus* Powell, 1944. Rec. Auck. Inst. Mus. 3 (1), p. 14.
*Micrelenchus oliveri cryptus* Powell, 1946. Rec. Auck. Inst. Mus. 3 (2), p. 139.
*Micrelenchus parcipictus* Powell, 1946. Rec. Auck. Inst. Mus. 3 (2), p. 138.
†*Mitrithara barrierensis* Powell, 1942. Bull. Auck. Inst. Mus. 2, p. 124.
†*Mitrithara fenestrata* Powell, 1944. Rec. Auck. Inst. Mus. 3 (1), p. 44.
†*Mitrithara sutherlandica* Powell, 1942. Bull. Auck. Inst. Mus. 2, p. 123.
†*Mitrithara waitakiensis* Powell, 1942. Bull. Auck. Inst. Mus. 2, p. 123.
*Murdochia annectens* Powell, 1948. Rec. Auck. Inst. Mus. 3 (4-5), p. 274.
*Murdochia filicosta* Powell, 1948. Rec. Auck. Inst. Mus. 3 (4-5), p. 274.
*Mysticoncha harrisonae* Powell, 1946. Rec. Auck. Inst. Mus. 3 (2), p. 144.
**Neoguraleus benthicola* Powell, 1942. Bull. Auck. Inst. Mus. 2, p. 136.
†*Neoguraleus deceptus* Powell, 1942. Bull. Auck. Inst. Mus. 2, p. 133.
†*Neoguraleus finlayi* Powell, 1942. Bull. Auck. Inst. Mus. 2, p. 137.
**Neoguraleus interruptus* Powell, 1942. Bull. Auck. Inst. Mus. 2, p. 136.
*Neoguraleus manukauensis* Powell, 1942. Bull. Auck. Inst. Mus. 2, p. 137.
†*Neoguraleus nukumaruensis* Powell, 1942. Bull. Auck. Inst. Mus. 2, p. 134.
**Neoguraleus oruaensis* Powell, 1942. Bull. Auck. Inst. Mus. 2, p. 137.
**Neoguraleus sandersonae* Powell, 1942. Bull. Auck. Inst. Mus. 2, p. 136.
*Neoguraleus whangaroaensis* Powell, 1942. Bull. Auck. Inst. Mus. 2, p. 135.
†*Neoguraleus (Fusiguraleus) angustatus* Powell, 1942. Bull. Auck. Inst. Mus. 2, p. 143.
†*Neoguraleus (Fusiguraleus) exsculptus* Powell, 1942. Bull. Auck. Inst. Mus. 2, p. 143.
†*Neoguraleus (Fusiguraleus) flexicostatus* Powell, 1942. Bull. Auck. Inst. Mus. 2, p. 141.
†*Neoguraleus (Fusiguraleus) granulatus* Powell, 1942. Bull. Auck. Inst. Mus. 2, p. 143.
†*Neoguraleus (Fusiguraleus) lawsi* Powell, 1942. Bull. Auck. Inst. Mus. 2, p. 142.
†*Neoguraleus (Fusiguraleus) major* Powell, 1942. Bull. Auck. Inst. Mus. 2, p. 141.
†*Neoguraleus (Fusiguraleus) mancus* Powell, 1942. Bull. Auck Inst. Mus. 2, p. 140.
†*Neoguraleus (Fusiguraleus) marwicki* Powell, 1942. Bull. Auck. Inst. Mus. 2, p. 142.
†*Neoguraleus (Fusiguraleus) nutans* Powell, 1942. Bull. Auck. Inst. Mus. 2, p. 140.
†*Neoguraleus (Fusiguraleus) platycostatus* Powell, 1942. Bull. Auck. Inst. Mus. 2, p. 140.
†*Neoguraleus (Fusiguraleus) porrectus* Powell, 1942. Bull. Auck. Inst. Mus. 2, p. 142.
†*Neoguraleus (Fusiguraleus) raricostatus* Powell, 1942. Bull. Auck. Inst. Mus. 2, p. 141.
†*Neoguraleus (Fusiguraleus) porrectus* Powell, 1942. Bull. Auck. Inst. Mus. 2, p. 142.
†*Neoguraleus (Fusiguraleus) subobsoletus* Powell, 1942. Bull. Auck. Inst. Mus. 2, p. 143.
†*Neoguraleus (Fusiguraleus) sutherlandicus* Powell, 1942. Bull. Auck. Inst. Mus. 2, p. 144.
†*Neothais lassa* Marwick, 1948. N.Z. Geol. Surv. Pal. Bull. 16, p. 32.
†*Notogenota finlayi* Powell, 1942. Bull. Auck. Inst. Mus. 2, p. 79.
†*Notopeplum balcombensis* Finlay, 1930. Trans. N.Z. Inst. 61, p. 46.
†*Notopeplum saginatum* Finlay, 1930. Trans. N.Z. Inst. 61, p. 45.
†*Optoturris editus* Powell, 1944. Rec. Auck. Inst. Mus. 3 (1), p. 12.
†*Otahua bartrumi* Marwick, 1948. N.Z. Geol. Surv. Pal. Bull. 16, p. 32.
†*Pachydontella etiampicta* Marwick, 1948. N.Z. Geol. Surv. Pal. Bull. 16, p. 28.
*Paralaoma regia* Powell, 1948. Rec. Auck. Inst. Mus. 3 (4-5), p. 279.
*Paralaoma turbotti* Powell, 1948. Rec. Auck. Inst. Mus. (4-5), p. 280.

*Paryphanta gilliesi aurea* Powell, 1946. Rec. Auck. Inst. Mus. 3 (2), p. 113.
*Paryphanta spedeni lateumbilicata* Powell, 1946. Rec. Auck. Inst. Mus. 3 (2), p. 105.
*Paryphanta superba harveyi* Powell, 1946. Rec. Auck. Inst. Mus. 3 (2), p. 110.
*Paryphanta superba prouseorum* Powell, 1946. Rec. Auck. Inst. Mus. 3 (2), p. 109.
*Paryphanta superba richardsoni* Powell, 1946. Rec. Auck. Inst. Mus. 3 (2), p. 110.
*Paryphanta traversi florida* Powell, 1946. Rec. Auck. Inst. Mus. 3 (2), p. 120.
*Paryphanta traversi koputaroa* Powell, 1946. Rec. Auck. Inst. Mus. 3 (2), p. 136.
*Paryphanta traversi otakia* Powell, 1946. Rec. Auck. Inst. Mus. 3 (2), p. 121.
*Paryphanta unicolorata johnstoni* Powell, 1946. Rec. Auck. Inst. Mus. 3 (2), p. 107.
*Paryphanta watti* Powell, 1946. Rec. Auck. Inst. Mus. 3 (2), p. 101.
†*Phenatoma precursor* Powell, 1942. Bull. Auck. Inst. Mus. 2, p. 109.
*Phrixgnathus subariel* Powell, 1948. Rec. Auck. Inst. Mus. 3 (4-5), p. 278.
†**Placostylus ambagiosus hinemoa* Powell, 1947. Rec. Auck. Inst. Mus. 3 (3), p. 182.
*Placostylus ambagiosus keenorum* Powell, 1947. Rec. Auck. Inst. Mus. 3 (3), p. 186.
†*Placostylus ambagiosus lesleyae* Powell, 1947. Rec. Auck. Inst. Mus. 3 (3), p. 184.
*Placostylus ambagiosus spiritus* Powell, 1947. Rec. Auck. Inst. Mus. 3 (3), p. 185.
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